STUDY OF A GROUND ACCESS SYSTEM FOR O'HARE INTERNATIONAL AIRPORT

Final Report Volume One
Evaluation of CBD-O'Hare Alternatives

Prepared for

CITY OF CHICAGO
DEPARTMENT OF PUBLIC WORKS

alan m. voorhees & associates, inc. ■ TRANSPORTATION & URBAN PLANNING

STUDY OF A GROUND ACCESS SYSTEM FOR O'HARE INTERNATIONAL AIRPORT (D-1-002)

FINAL REPORT

VOLUME I

EVALUATION OF CBD-O'HARE ALTERNATIVES

August 1973

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CITY OF CHICAGO
DEPARTMENT OF PUBLIC WORKS

By

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I. INTRODUCTION

STUDY BACKGROUND

As airline traffic and air passenger activity grow at O'Hare International Airport, the ground access system which supports the airport will be placed under increasing stress. With the prospect of passenger enplanements increasing by over 50 percent by 1985,[1/] the City of Chicago recognized the need for conducting a comprehensive study of O'Hare's ground access system and retained Alan M. Voorhees & Associates, Inc. to prepare a regional access plan. This plan is intended to meet O'Hare's ground access needs at the 30 million annual passenger enplanement level.

The studies and analyses to be performed by AMV as part of the access plan development were divided into three phases. Phase I consisted of the development of a detailed work program for the study and the assembly of relevant data. A work flow diagram for the study is presented in Appendix G of this report. Phase II, as originally conceived, was to produce a long-range access plan regional in scope; however, it became evident during the course of the Phase II studies that an O'Hare-CBD access system would be the foundation and most significant element of the regional access system. Accordingly, AMV's efforts in Phase II focused on the evaluation of CBD-O'Hare system alternatives. Phase III of the study consisted of detailing and refining the recommended CBD-O'Hare system and completing those elements of the study necessary for the recommended airport access plan to be regional and comprehensive in scope.

[1/] Landrum and Brown, Inc., Airport Layout Plan Report for Chicago-O'Hare International Airport, Prepared for City of Chicago, 1971.

[2/] Alan M. Voorhees & Associates, Inc., Work Program, Study of a Ground Access System for O'Hare International Airport, Prepared for City of Chicago, November 1971.

Paralleling the manner in which the study was conducted, the final report for the study consists of two volumes. This document, Volume I, describes the studies and analyses which were performed in Phase II of the study. Volume II presents the recommended access plan for O'Hare.

DEVELOPMENT OF CBD-O'HARE ACCESS ALTERNATIVES

During the course of Phase II work, a number of alternative CBD oriented airport access systems were analyzed. The intention of such an effort was to develop a comprehensive listing of potential alternatives for further analysis, testing, and evaluation. Six fixed route alternatives were identified as potentially feasible airport systems. Additionally, three other systems were partially evaluated, and recommendations were made for ceasing further study. These were: dual-mode vehicles -- rejected on the basis of continuing technological problems; busways -- rejected on the basis of infeasibility of obtaining required highway lanes; and use of the Soo Line right-of-way -- rejected because of the impracticability of right-of-way usage due to railroad yard congestion and capacity constriction.

Of the six remaining fixed route alternatives, a selection process ensured which provided alternatives for further testing which would (1) encompass differing routes, and access and distribution methods such that resulting impacts could be more readily assessed; and (2) provide alternatives with wide levels of service characteristics.

The four alternatives finally selected for Phase II testing and evaluation are those described in Chapter III.

CONTENTS OF VOLUME ONE

The remainder of this document describes Phase II work and consists of six chapters plus appendices as follows:

- II. Forecasted Airport Access Demand at the 30 Million Annual Enplanement Level -- This chapter presents the forecasted ground access demands which will be placed upon O'Hare's access system at the 30 million annual passenger enplanement level. In particular, it describes the projected geographic distribution of air passenger and airport employee local origins and destinations in 1983.
- III. Evaluation Criteria and Definition of Alternatives -- The first section of this chapter describes the evaluation criteria which was employed in the analyses. First it divides the criteria into four major categories, and then it discusses the detailed elements of the criteria. The second section presents a detailed description of the alternatives selected for testing indicating their respective system characteristics.
- IV. Characteristics and Impacts of Alternative Access Systems -- The purpose of this chapter is to describe the impacts of the alternative O'Hare-CBD systems with regard to evaluation factors which must be handled in a qualitative rather than quantitative manner. These factors are divided into three major categories - airport-oriented service availability, travel accommodations, and non-airport related impacts.
- V. Utilization Projections of Alternative O'Hare-CBD Access Systems -- Contained in this chapter are forecasts of the extent to which each potential group of users would utilize the systems under consideration, including air passengers, airport employees, airport visitors, and non-airport oriented users. In addition, it presents preliminary forecasts of the impacts to existing commuter rail services of a CTA extension from Jefferson Park to O'Hare. Appendices A, B, C and D describe in detail the analytical procedures employed.

- VI. Cost and Revenue Estimates of Alternative O'Hare-CBD Access Systems -- For each alternative, this chapter presents estimates of construction costs, vehicle costs, operating costs, and potential revenue. Appendix E includes a detailed construction cost breakdown and Appendix F focuses on the particular assumptions which were made to complete the operating cost analysis.

- VII. Summary and Recommendations -- The final chapter summarizes the forecasts, estimates, and results presented in earlier chapters indicating comparatively the potential ability of the alternatives tested to satisfy the evaluation criteria. The final section of this chapter presents the Consultant's recommendations and the underlying rationale.

ACKNOWLEDGEMENTS

During the course of AMV's work to date on the O'Hare Ground Access Study, a number of public agencies and private corporations have provided assistance, particularly with regard to data. Below is a partial list of these agencies and corporations.

- City of Chicago
  - Department of Public Works
  - Department of Aviation
  - Department of Development and Planning
- Illinois Department of Transportation
  - Research and Development
  - Division of Highways
- Chicago Area Transportation Study (CATS)
- Chicago Transit Authority
- Chicago and North Western Railroad
- Chicago, Milwaukee, St. Paul and Pacific Railroad
- Continental Transport Company
- Greater North Michigan Avenue Association
- Chicago Transit Planners, Inc.

NOTES

For simplicity, airport ground access/egress trips will be generally referred to in this report as simply access trips. Usually these trips will be discussed on the basis of origin-to-airport, although it is understood that approximately half of the trips are airport-to-destination.

It should also be noted that much of the material presented in this report was previously included in interim technical memoranda and reports. Whenever there are conflicts, this report takes precedence and supercedes earlier memoranda.

II. FORECASTED AIRPORT ACCESS DEMAND AT THE 30 MILLION ANNUAL ENPLANEMENT LEVEL

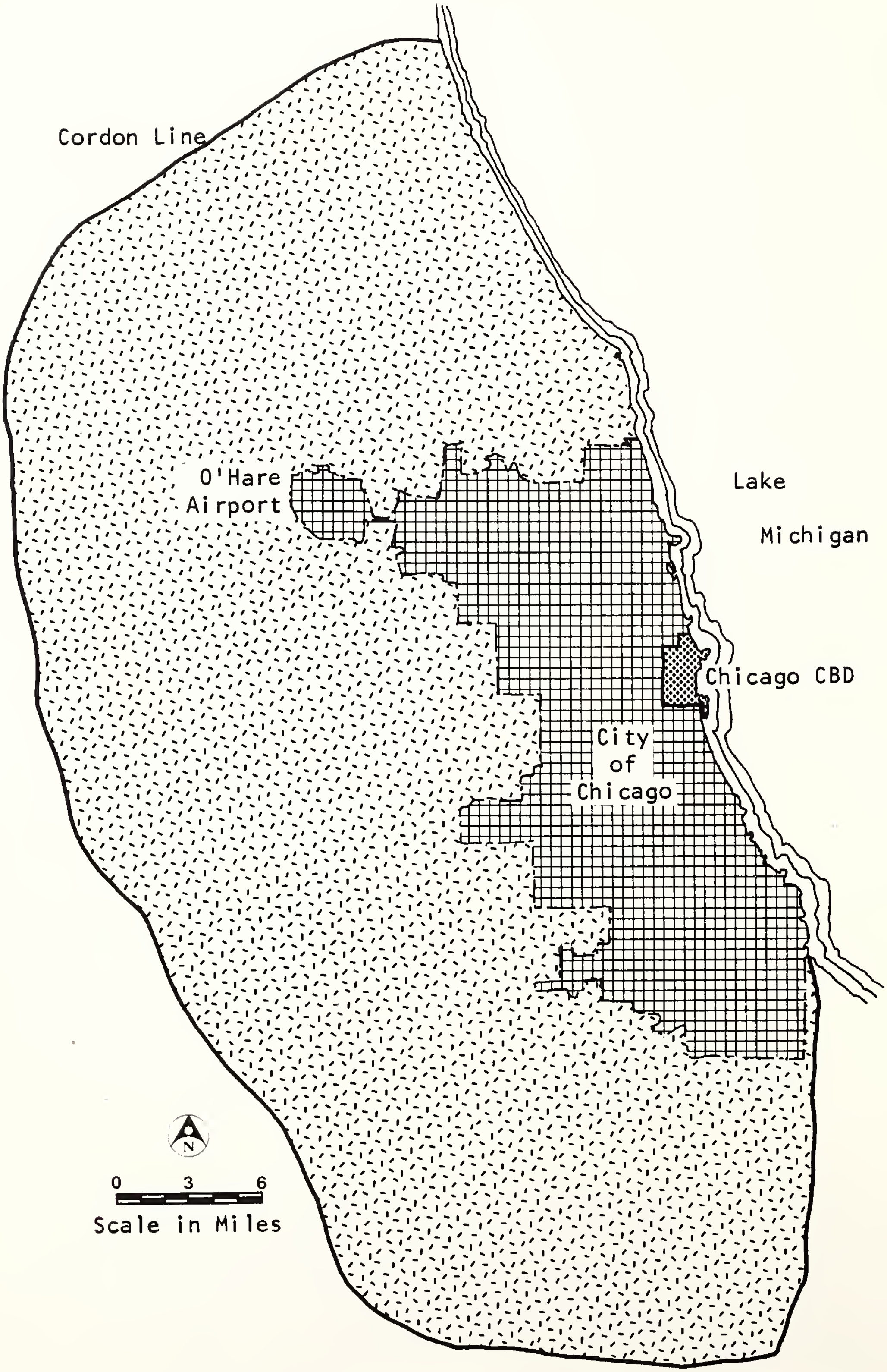
BACKGROUND

The purpose of this chapter is to present forecasts of the access demand which will exist for O'Hare International Airport at the 30 million annual passenger enplanement level. In order to conceive, plan, and evaluate alternative access systems, it is necessary to describe this demand in terms of the local origin-destination (O-D) distribution of potential airport access system users. These users may be divided into the following four groups for analysis purposes:

- Air Passengers -- Those persons traveling to or from the airport who are either departing by aircraft or who have arrived by aircraft.
- Employees -- Those persons traveling to or from the airport to reach jobs based at the airport.
- Visitors -- Airport visitors can be subdivided into two subgroups:
  - Travel-Related Visitors -- Those persons traveling to or from the airport to either bid farewell or greet air passengers.
  - Casual Visitors -- Those persons not associated with air passengers traveling to or from the airport to do such things as sightsee, purchase tickets in advance, patronize or service concessions.
- Residual Users -- All remaining persons who travel to and from the airport, including the drivers of ground transit vehicles, passenger or cargo.

The remainder of this chapter will present projections of the future O-D distribution for air passengers and airport employees and describe the methods which were employed to obtain them. Because airport visitor generation rates are closely related to the access mode of air passengers and available access modes, airport visitor forecasts cannot be presented

FIGURE II-1
STUDY AREAS



until Chapter V (see page 81). Residual users are omitted from the analysis entirely because, as the group is defined, the majority of its members are related to a particular highway transport mode, and therefore will not affect the planning and evaluation of alternative O'Hare-CBD access systems, the primary focus of this report.[1/]

Before discussing the projections for the various user groups, some comments should be addressed to the analysis areas and design year used in the forecasting process.

Analysis Areas for Distribution of Air Passengers

For analysis purposes, access system users were considered as originating or departing from one of four areas, shown in Figure II-1:

- The CBD as defined by the 1964 and 1969 Air Passenger Surveys plus an additional area in the north. This includes the area bounded by the Lake (E), Chicago Avenue (N), Halsted Street (W), and Roosevelt Street (S), plus the area immediately north of Chicago Avenue bounded by State Street, North Avenue and the Lake. (See Figure II-2.)
- The area beyond the CBD but within the city limits of Chicago.
- The area beyond the city limits but within the cordon boundary defined by CATS.
- The remaining areas outside the CATS cordon.

It was recognized, in selecting these areas, that the growth rate in terms of air passenger origins and destinations is different in each of the areas. This can be seen from the results of the 1964 and 1969 Air Passenger Surveys in Table II-1. This table shows a dramatic decrease in the relative importance of the CBD air passenger origins and destinations, although there was an increase in the absolute number of trips.

1/ In Phase III of this study, a range of highway and traffic improvements will be identified in which residual user demands, especially cargo-related, will have an impact.

FIGURE II-2
CHICAGO CBD

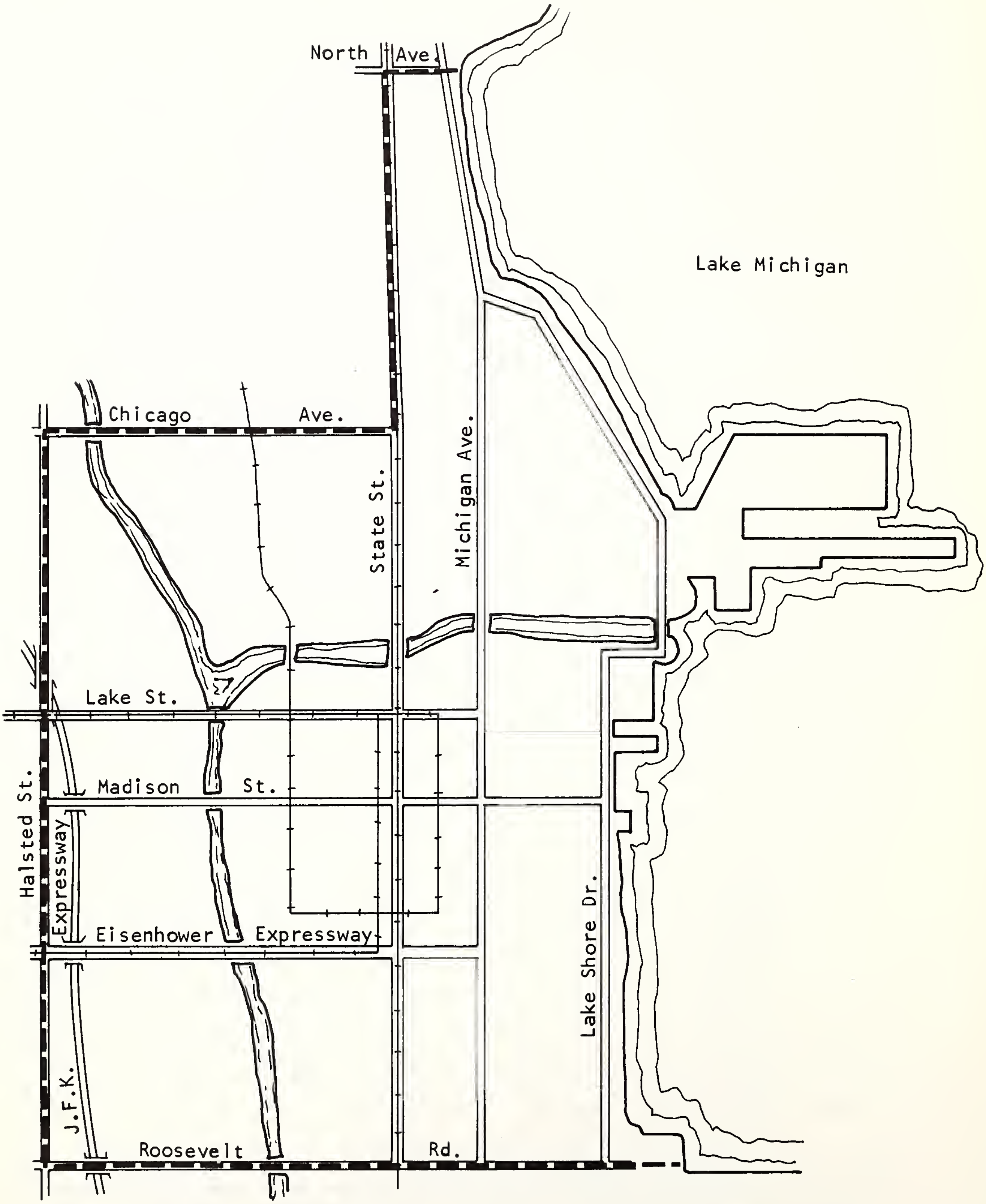


TABLE II-1. COMPARISON OF THE DISTRIBUTION OF ORIGINS FOR DEPARTING AIR PASSENGERS IN 1964 AND 1969.

Area	1964 Departures for an Average Wednesday in October (%)	1969 Departures for an Average Wednesday in April (%)	Annual Growth Rate Between 1964 and 1969 (%)
CBD	41.0	33.3	3.7
City outside CBD	16.7	20.8	13.8
Beyond City Limits but Within CATS Cordon	35.3	32.4	6.6
Beyond CATS Cordon Limits	6.8	13.5	26.6
	100.0	100.0	

NOTE: Table reflects the influence of unusually large convention breaks. Table II-4 includes an adjustment for this effect.

Design Year for 30 Million Enplanement Level

The design year suggested by the City of Chicago for these projections is the 30 million enplanement level. In 1971 Landrum & Brown, Inc.,[1] airport planning consultants to the City of Chicago, made estimates of future air passengers who would use O'Hare International Airport. From this report it is estimated that the 30 million enplanement level will occur in 1983.

AIR PASSENGER ACCESS/EGRESS DEMAND

Prediction Procedure

The estimating procedure for determining the distribution of air passengers in 1983 consisted of the following steps:

- Determining the average daily departure volume at O'Hare in 1983.
- Extrapolating to 1983 the growth observed between 1964 and 1969 Air Passenger Surveys for departing passengers in each of the four analysis areas.
- Normalize each of these results to give the projected average daily departure volume for 1983.
- Use the 1964 ratio of departing air passengers to arriving passengers to project the number of arriving passengers in each of the four areas.

The average daily departure volume in 1983 was estimated by considering the annual enplanement level of 30 million. The measure of air passenger enplanements includes passengers originating in Chicago, passengers transferring to other flights, and passengers continuing on the same flight. In 1969 it was estimated that only 55 percent of total enplanements were

[1] Airport Layout Plan Report, City of Chicago, April 1971.

air trips originating in Chicago. Assuming this pattern will continue, it was estimated that the 30 million enplanement level would generate an average of 45,200 daily departures (see Table II-2).

<u>Origins for Departing Air Passengers</u>

In projecting the 1983 departure volumes according to area of origin, it was assumed that the growth rate observed in each of the four areas between 1964 and 1969 would continue until 1983. The estimate of 1983 departure volumes by area were then normalized to give the average daily departure volume for all areas combined. These results are shown in Table II-3.

The use of a single linear growth function was considered adequate because no fundamental changes to alter these trends could be foreseen in the short time period to 1983. Attempts were made to identify variables which described these trends using multiple linear regression analysis. However, after an initial investigation this had to be abandoned because of the unavailability of future land use data. It was also felt that the statistical stability of the estimating equations was weak and would produce more erroneous results than the method selected.

Prior to making these forecasts, adjustments were made to the 1964 and 1969 Air Passenger Survey results to account for reporting bias. The 1964 Air Passenger Survey reported:[1/]

> "Convention breaks resulted in a rather heavy departure from the Central Zone."

[1/] O'Hare Airport Passenger Survey - General and Statistical Data, City of Chicago, November 1965.

TABLE II-2. ESTIMATE OF AVERAGE DAILY DEPARTURE VOLUME FOR 1983

	1969	1983
Total Enplanements	15,061,000 [1/]	30,000,000
Average Daily Enplanements	41,265	82,192
Average Daily Departures [2/]	22,696	45,205
Average Wednesday Departures	24,199 [3/]	48,188
Average Daily Departures as Percent of Average Wednesday Departures	94	94

[1/] FAA Statistical Handbook of Aviation, 1970.

[2/] Assumes 45 percent transfers and through trips as estimated from 1969 Air Passenger Survey.

[3/] 1969 Air Passenger Survey.

TABLE II-3. DISTRIBUTION OF ORIGINS FOR 1983 AVERAGE DAILY DEPARTURE VOLUME.

Area	1964 Survey	1964 Adjusted Survey	1969 Survey	1969 Adjusted Survey	1983 Estimate	1983 Adjusted Estimate
CBD	6,855	6,250 1/	8,055	8,055	13,269	13,486
City Outside CBD	2,812	2,812	5,022	4,220 1/	8,288	8,423
Beyond City Limits but Within CATS Cordon	5,899	5,899	7,838	7,838	13,440	13,660
Beyond CATS Cordon Limits	1,139	1,139	3,284	3,284	9,481	9,636
	16,705	16,100	24,199	23,391	44,478	45,205

1/ Adjusted for unusual convention breaks.

TABLE II-4. CHANGES IN THE DISTRIBUTION OF ORIGINS FOR DEPARTING PASSENGERS.

Area	% Distribution of Origins for Departing Air Passengers 1964[1]	1969[1]	1983	Percent Annual Growth Rate From 1969 To 1983[2]
CBD	38.8	34.4	29.8	4.5
City Outside CBD	17.4	18.0	18.7	6.0
Beyond City Limits but Within CATS Cordon	36.6	33.5	30.2	4.9
Beyond CATS Cordon Limits	7.2	14.1	21.3	9.2

[1] Adjusted for unusual high convention break.

[2] Growth rates are cumulative, not linear.

To account for this bias, the arrivals and departures in the CBD for air passengers not resident in Chicago were averaged and the total departures in the CBD adjusted accordingly. This was the same approach as that used by Real Estate Research Corporation. [1/]

In the 1969 Air Passenger Survey a similar bias was found because of a large convention break at the Union International Amphitheater. To account for this bias a reduction was made in the number of departures in the area defined as outside the CBD but within the city limits.

The estimates of the origin for departing air passengers at the 30 million enplanement level predict some significant changes in the distribution of origins between 1969 and 1983. The changes are shown in Table II-4.

A feature of this table is the continued decline in the relative importance of the CBD as a generator of air passenger trips. The remainder of the City of Chicago within the city limits is projected to have slightly increasing importance as a generator of air passenger trips. While outside the city limits it is the area beyond the CATS cordon boundary which is expected to achieve increasing significance rather than the closer areas. These areas are expected to decline in importance. This shift in air passenger origins indicates the growing importance of O'Hare as a regional airport.

Destinations for Arriving Passengers

Prediction of future destinations for arriving air passengers could not be made in the same manner as departing air passengers because data was only available for 1964. The 1969 survey only interviewed departing passengers.

[1/] Chicago Airport Site Selection Study: An Analysis of Some Major Considerations, 1968.

TABLE II-5. RATIO OF ARRIVALS TO DEPARTURES.

Area	No. of Arrivals 1964 [1]	No. of Departures 1964 [1]	Total No. of Air Passengers 1964	No. Arrivals / No. Departures 1964
CBD	5,509	6,250	11,759	0.88
City Outside CBD	2,655	2,744	5,399	0.97
Beyond City Limits but Within CATS Cordon	6,695	5,758	12,453	--
Beyond CATS Cordon Limits	1,004	1,111	2,115	--
	15,863	15,863	31,726	

[1] Adjusted for excessive convention breaks and to make total departures equal total arrivals.

TABLE II-6. DISTRIBUTION OF ORIGINS FOR AN AVERAGE DAY 1983.

Area	Number of Departures 1983	Number of Arrivals 1983	Total Arrivals and Departures 1983
CBD	13,486	11,868	25,354
City Outside CBD	8,423	8,171	16,594
Beyond City Limits but Within CATS Cordon	13,660	15,530	29,190
Beyond CATS Cordon Limits	9,636	9,636	19,272
	45,205	45,205	90,510

The 1964 Air Passenger Survey, which did interview arriving and departing passengers, observed a larger number of departing passengers in the CBD than arriving passengers. This indicated that people working in the CBD and desiring to make an air trip were more likely to leave from the CBD, and on returning to go directly home, than vice versa. Table II-5 demonstrates this fact where arrivals in the CBD equal 88 percent of the departure rate as compared to 97 percent in the suburban area immediately outside the CBD. Using this fact for the 1983 departures, it was possible to estimate the arrivals in these areas. Two further assumptions were then made:

- Arrivals would equal departures for persons using O'Hare International Airport.
- Arrivals would equal departures for persons originating or departing from the area beyond the CATS cordon limits.

The remaining arriving passengers were allocated to the suburbs between the city limits and the CATS cordon. This assumed they were passengers employed in the CBD and returning home. The results of these calculations are shown in Table II-6.

Table II-7 shows the anticipated changes in the distribution of destinations for arriving air passengers. The changes are similar to those expected for departing passengers. The most significant of these changes discussed earlier were:

- The decline in the relative importance of the CBD as an attractor of air passenger trips.
- The increase in the relative importance of the area beyond the local government limits of the City of Chicago.

In Table II-8 the distribution of arriving and departing air passengers have been combined to present the total growth in air passengers for the four sub-areas which O'Hare serves.

TABLE II-7. CHANGES IN DISTRIBUTION OF DESTINATIONS FOR ARRIVING PASSENGERS.

Area	% Distribution of Destinations For Arriving Passengers 1964	1983	% Annual Growth Rate 1964-1983[1/]
CBD	34.7	26.3	4.9
City Outside CBD	16.7	18.1	7.0
Beyond City Limits but Within CATS Cordon	42.2	34.4	4.4
Beyond CATS Cordon Limits	6.3	21.3	13.9
	100.0	100.0	

TABLE II-8. CHANGES IN DISTRIBUTION OF AIR PASSENGERS BY AREA OF ORIGIN/DESTINATION 1964-1983.

Area	% Distribution of Total Air Passengers 1964	1983	% Annual Growth Rate 1964-1983[1/]
CBD	37.1	28.0	4.9
City Outside CBD	17.0	18.4	7.0
Beyond City Limits but Within CSTS Cordon	39.2	32.3	4.4
Beyond CATS Cordon Limits	6.7	21.3	13.9

[1/] Growth rates are cumulative, not linear.

Distribution Within Analysis Areas

In order to conduct the analyses and forecasts of access mode choice discussed in Chapter III, it was necessary to forecast the distribution of air passenger origins and destinations within each of the four major analysis areas. For the three analysis areas other than the CBD, forecasts were made by combining CATS traffic zones to four square-mile districts. It was then assumed the future distributions of origins and destinations within each major analysis area will remain the same as observed in the 1969 air passenger survey.

In the CBD, CATS traffic zones were again used; however, the distribution was modified to take account of expected changes in employment[1/] and hotel development.[2/] Figure II-3 illustrates the resulting forecasted 1983 distribution.

AIRPORT EMPLOYEE ACCESS DEMAND

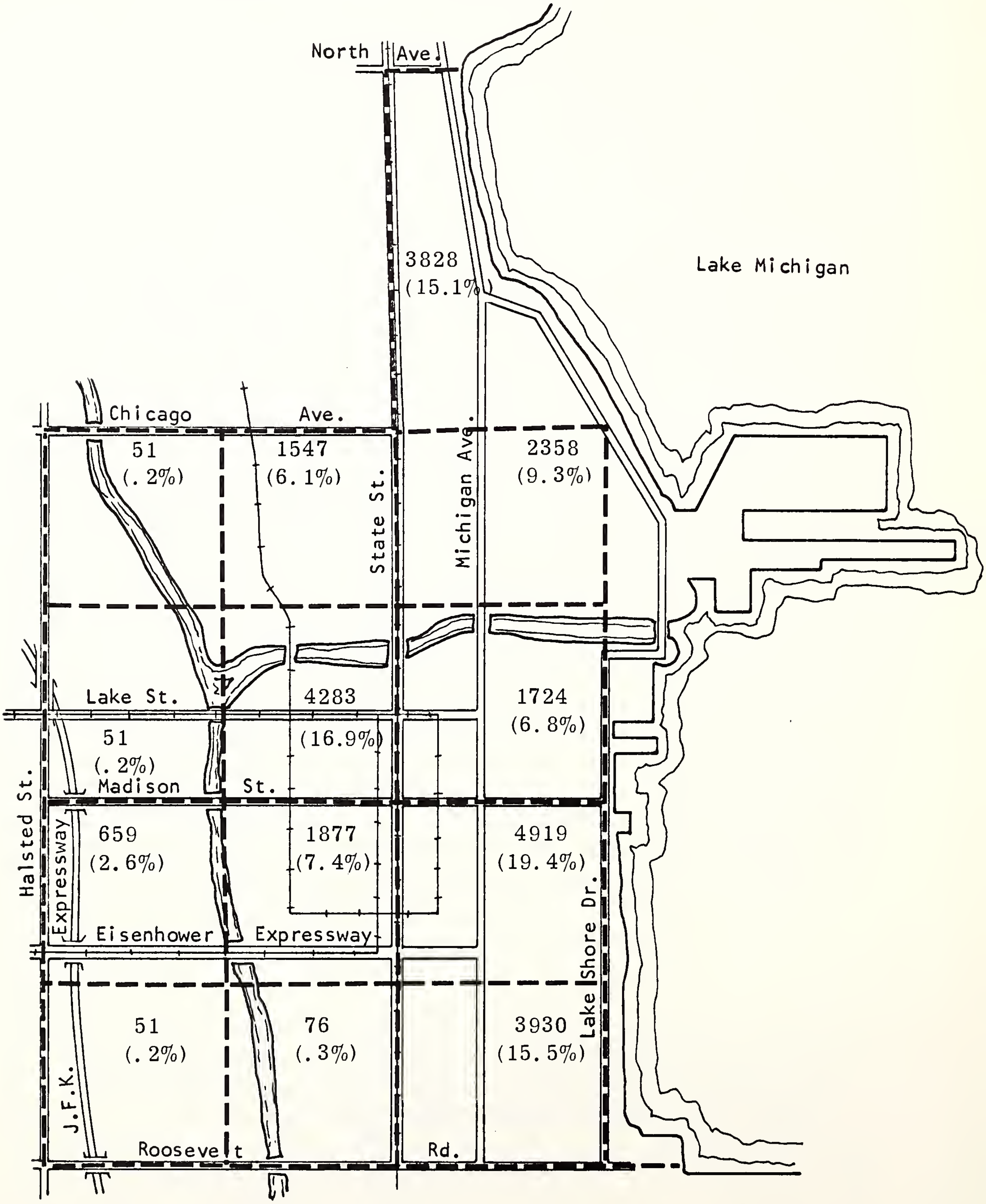
In general, the origins and destinations of airport employee work trips correspond to the residential locations of the employees. Thus, to evaluate alternative access systems with respect to their ability to serve airport employees, forecasts of the residential distribution of future employees are required.

1/ Real Estate Research Corp., "Analysis of Development Potential in the Chicago Central Area," contained in Vol. III of the Chicago Central Area Transit Planning Study, April 1968.

2/ Hotel construction forecasts provided by

FIGURE II-3

FORECASTED AVERAGE DAY 1983 DISTRIBUTION OF AIR PASSENGER ORIGINS AND DESTINATIONS IN CBD.



NOTE: Zones correspond to CATS Traffic Zones.

Future Airport Employment

Between 1960 and 1968 air passenger enplanements increased by almost 200 percent; however, the ratio of airport-employees to enplaned passengers declined by 47 percent.[1/] Figures II-4 and II-5 illustrate this decline. The decline reflects the fact that a substantial portion of airport employees are "fixed;" that is, they remain constant or grow only slightly in numbers as air passenger volumes increase. The decline also reflects the increase in productivity of airport employees which has been experienced over the past ten to fifteen years.

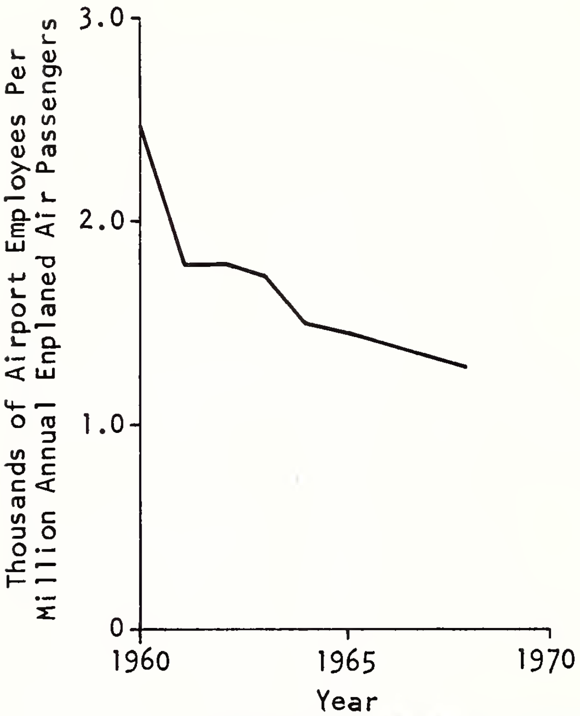
To what extent this trend at O'Hare will continue into the future is largely unknown. With the exception of the new hotel at the airport, no major additions in passenger related services or concessions are planned for O'Hare through 1983. This is also the case with maintenance activities. Thus, we can expect employees engaged in these services to continue to decline in relation to passenger enplanements as relatively "fixed" numbers of employees serve increasing numbers of air passengers. Air cargo, however, is expected to increase dramatically in the next fifteen years. Nationally, growth by a factor of over 700 percent with respect to annual tonnage has been predicted in air cargo.[2/] Since air cargo is expected to increase at a rate substantially greater than air passengers, it may be anticipated that the ratio of cargo-related employees to enplaned passengers might actually increase by 1983. Increased containerization, however, which will be necessary to achieve the forecasted increases in air cargo, may also bring dramatic increases in cargo-oriented employee productivity. Unfortunately, there is little data currently available which could be used to access the quantitative impact on airport employment of increases in air cargo.

[1/] Chicago Central Area Transit Planning Study, Vol. III, 1968, p. IV-40.

[2/] Simat, Helliesen and Eichner, Inc., Study to Update Air Traffic Forecasts and Allocate Demand and Air Traffic prepared for Aviation Advisory Commission, 1971.

FIGURE II-4

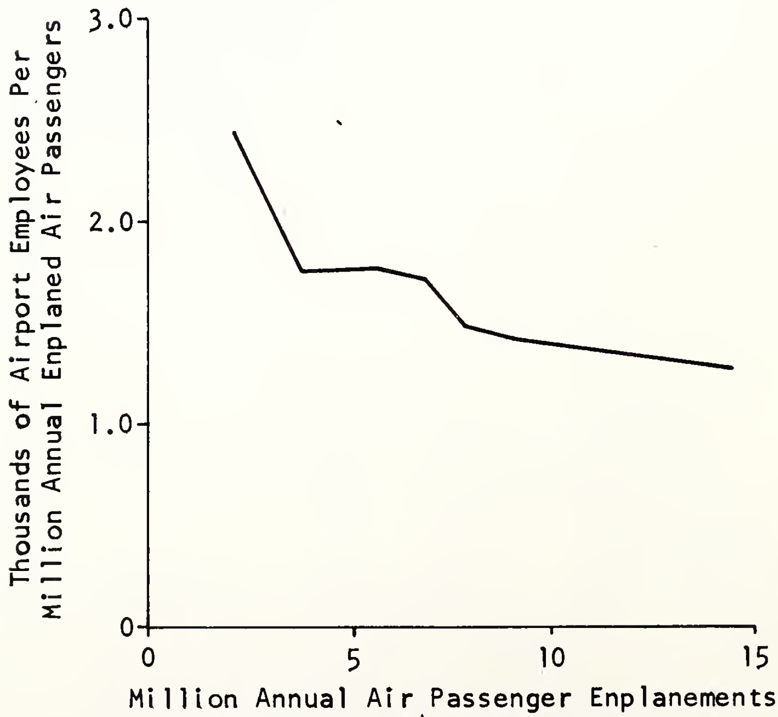
EMPLOYEE TO ENPLANED PASSENGER RATIO BY YEAR
O'HARE INTERNATIONAL AIRPORT



Sources: "Chicago Central Area Transit Planning Study," Volume III, 1968 and Chicago Department of Aviation Records

FIGURE II-5

EMPLOYEE TO ENPLANED PASSENGER RATIO VERSUS
ANNUAL ENPLANED PASSENGERS
O'HARE INTERNATIONAL AIRPORT



Source: "Chicago Central Area Transit Planning Study," Volume III, 1968 and Chicago Department of Aviation Records

In order to forecast the number of employees working at O'Hare in 1983 (the assumed year in which 30 million enplanements will be attained), it has been assumed that the observed decline in the employee to enplaned passenger ratios will continue through 1983, though at a lesser rate. It is assumed that in 1983, 1,030 employees will be required per million annual passenger enplanements -- a decline of 20 percent from the 1968 rate. For 30 million enplanements, this produces a forecast of 31,000 airport employees at O'Hare in 1983.

Future Residential Distribution of Airport Employees

In 1968 a survey of O'Hare employees was conducted for the City of Chicago. This survey is the only significant data source available for estimating existing residential distribution of O'Hare employees which can be used, in turn, as a basis for estimating the future distribution.[1/]

The survey obtained a 30 percent sample and was factored on the basis of airport employers for which control totals are available. Using the analysis areas described previously, Table II-9 illustrates the estimates of the 1968 residential locations of O'Hare employees which were obtained.

In order to estimate the future distribution of residential locations, the possibility of developing relationships which tie land use and land activity to 1968 employee locations was investigated. However, the absence of survey information on employee income and the absence of uniform base year (1968) and design year (1983) land activity measures foreclosed this possibility. Instead, it was decided that the 1968 percentage distribution

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[1/] A survey of airline employees working in the Chicago Region was conducted in 1970 by the Air Transport Association; however, it did not distinguish employees by specific work location. Thus, it includes airline employees working at Midway and sales offices as well as employees working at O'Hare.

TABLE II-9. 1968 RESIDENTIAL DISTRIBUTION OF O'HARE EMPLOYEES.

Area	Percentage
CBD	1
City Outside CBD	46
Beyond City Limits	49
Beyond Cordon Limits	4
	100

TABLE II-10. 1983 RESIDENTIAL DISTRIBUTION OF O'HARE EMPLOYEES.

Area	Number of Employee Residences
CBD	310
City Outside CBD	14, 260
Beyond City Limits	15, 190
Beyond Cordon Limits	1, 240
	31, 000

of employee locations without modification is the best estimate of the 1983 distribution. Because there are no a priori reasons for expecting dramatic shifts in O'Hare employee residential locations between 1968 and 1983, this assumption does not appear unreasonable.

Implicit in the procedure of using the 1968 distribution to predict the 1983 distribution of employee residences, is the assumption that future employee residential locations will not be sensitive to changes in the O'Hare access system. In reality, employee locations do shift in response to access system changes as old employees relocate to more accessible areas and new employees are hired in areas previously considered inaccessible.[1/] Major changes are required in access systems before these phenomenon become significant, however. Given the current automobile mode share[2/] and the characteristics of the non-highway alternatives to be examined in this study, expected changes in the employee residential distribution due to alternative access system improvements would be of a "second-order" nature. Thus, the assumption of a constant distribution of employees independent of access system alternatives seems to be justified in this case. Nevertheless, each alternative still must be evaluated with respect to its ability to open up job opportunities to areas of Chicago which are at present relatively inaccessible to O'Hare.

Using the 1968 distribution and the forecast of 1983 airport employment, the 1983 distribution of airport employee locations was obtained as shown in Table II-10. It should be noted that the actual employee residential distribution forecasts were developed for four square-mile CATS analysis zones and have been aggregated to obtain the figures shown in the table.

[1/] For example, the O'Hare express service has improved the accessibility of certain Chicago areas to O'Hare, increased O'Hare employement in these areas, and thus affected the overall distribution of O'Hare employee residential locations.

[2/] According to the 1968 survey, 96 percent of O'Hare's employees used the private auto for airport access at that time.

III. EVALUATION CRITERIA AND DEFINITION OF ALTERNATIVES

EVALUATION CRITERIA OVERVIEW

Criteria for the evaluation of alternative transportation systems must be concerned with the relationships and dependencies existing among such factors as system costs, system users, and system characteristics.

In the special case of an airport access system, the diversity of potential users promotes two particular aspects as significant evaluation criteria elements: (1) appeal to the broadest possible range of potential user groups, and (2) the most favorable overall regional impact.

The evaluation criteria may be generally categorized into four basic topics which follow in separate discussions.

Passenger Utilization Forecasts

One of the most important elements defining the attractiveness of any access system alternative is its economic viability, which in turn depends upon that system's potential for attracting and holding passengers. Thus, given assumptions about the existence of a certain set of access system characteristics, ridership projections were made using models and procedures described in a later chapter. These usage predictions form the foundation of quantitative evaluation criteria, as by applying their numbers, revenues, operational costs, and vehicle needs can be estimated. This in turn provides great insight into the probable economic viability of the access system alternative under consideration.

Level-of-Service Characteristics

Mathematical models which predict human behavior with respect to transportation mode choice do so largely on the basis of assigning known, assumed, or estimated values to the probability of group or individual reactions to transportation system characteristics. Thus, to rationally analyze selections from among alternative airport access systems, the systems are defined with differing - but high - level-of-service characteristics. And although the application of predictive procedures of human choice to system characteristics is largely an analytical one, the selection of rational high level-of-service characteristics by which to define an alternative system is a matter of judgement based on experience.

Financial Considerations

Although certain alternative airport access systems may have obvious first cost advantages, while others may have obvious financial complexities, it is desirable to select alternatives for testing which can show the effects of cost extremes. Thus, associated with a high first cost may be considerable service advantages; these can be tested and quantified for user impact.

Conversely, alternatives with clearly limited service features of one or more types may have considerable first-cost economies. These may also be measured for impact.

Thus, although first-cost implications are always of great significance, it is nevertheless of considerable importance to test and evaluate marginal service improvement implications associated with respective marginal first-cost increases. This procedure obtains a more complete relative perspective of alternative system merits, beyond those of simple dollar-total analysis. Similar associations may be made for operating costs.

Overall Regional Impact

Although, in its narrowest definition, an airport access facility may be considered only a link, connecting a downtown area with a suburban transportation facility, in fact, such a system has widespread regional effects which, if subtle, are nevertheless of great significance in an urban area as large as that of Chicago. The airport itself may be considered a satellite central business district, with significant commercial interests and a sizeable employment center. Thus, depending upon a given alternative access system, widespread commercial and personal pattern changes may result. For these reasons, the impact on the region as a whole is included as an important part of system evaluation criteria.

EVALUATION CRITERIA DETAIL

Quantitative Elements

Applying the methods described in Chapter V, forecasts were made for system usage for each alternative by air passengers, employees, and visitors. For purposes of this analysis, the alternative access systems were defined as below. The system definitions assumed the major service characteristics (such as headway and line-haul run-times) shown, and the fare structures indicated in Chapter V. Sensitivity analysis of user groups to fares was performed so as to provide data indicating the particular fare level which would maximize annual system revenues.

Based on assumptions of service frequency, vehicle size and loading capacity, as well as existing operational practices and costs on the CTA, vehicle fleet size and system operating costs were projected. The construction feasibility for complex alternatives was assessed; construction cost estimates were then made for each access system alternative.

In addition to assessing in this manner the direct impact of alternatives, passenger diversion to a competing mode -- the C&NW commuter service on the Northwest Line -- was predicted following the methods described in Appendix C.

As non-airport related ridership would also be of significance in judging the merits of alternative airport access systems, estimates for these volumes are important. Thus, assignments developed by CATS, in association with the Crosstown Transit Study, for passenger usage in intermediate stations between Jefferson Park and O'Hare, were incorporated into total patronage projections, as shown in Chapter V. This procedure enables comparisons to be made between alternative system ridership versus system fare structure, alternative system ridership versus system first cost, and anticipated revenues versus projected operating cost for each alternative.

Qualitative Elements

Service availability to airport passengers and employees is considered a most significant aspect of evaluation criteria, especially as it relates to CBD distribution. Access system alternatives having widespread downtown distribution automatically become more "available" from regional access points as transfers from existing transportation modes are made more easily.

Additionally, widespread downtown distribution promotes system usage from a wider geographical section of the CBD itself, having reciprocal beneficial effects on business and commercial interests which may rely in large part on the impact of public transportation systems. In addition to the Loop area, other districts so designated include the Near Northside (Gold Coast) and South Michigan Avenue areas.

Underutilized existing transportation facilities which may in some manner be incorporated into proposed designs for one or more system alternatives reduce the need for new facilities; resultant construction and acquisition costs may thus be lower. Intensification of use of available terminals, rights-of-way, and other major elements of the system is considered highly important.

Access system convenience and accommodation elements weigh heavily in a potential user's attitude toward public transportation. The following are some of the more important aspects of convenience and accommodation which have been considered with respect to alternatives for O'Hare access:

- Transfers -- Will the proposed alternative help minimize total modal transfers for the origin point to O'Hare trip?
- Trip Time -- Is the total trip time, including walking, transfer, waiting, and line-haul time minimized?
- Terminals -- Is there good potential for CBD satellite terminal (should this be desired in the future) which would provide ticketing, baggage check-in, and kiss-and-ride/taxi accommodations?
- Regularity -- Would the access system provide highly regular and dependable service regardless of time of day?
- Loadings -- Would extreme passenger loadings be avoided during the rush hour?
- Baggage -- Would adequate provision be made for turnstile, escalator, and vehicle baggage facility?
- Express -- Would the system provide express service for premium fare passengers? In its absence, would non-stop service be available?
- Comfort -- Would vehicle accommodations and seat dimensions provide comfort elements on a similar scale to that provided in a modern airliner?
- Security -- Would a user's perceived security on such a public access system be somewhat similar to that of competing modes?

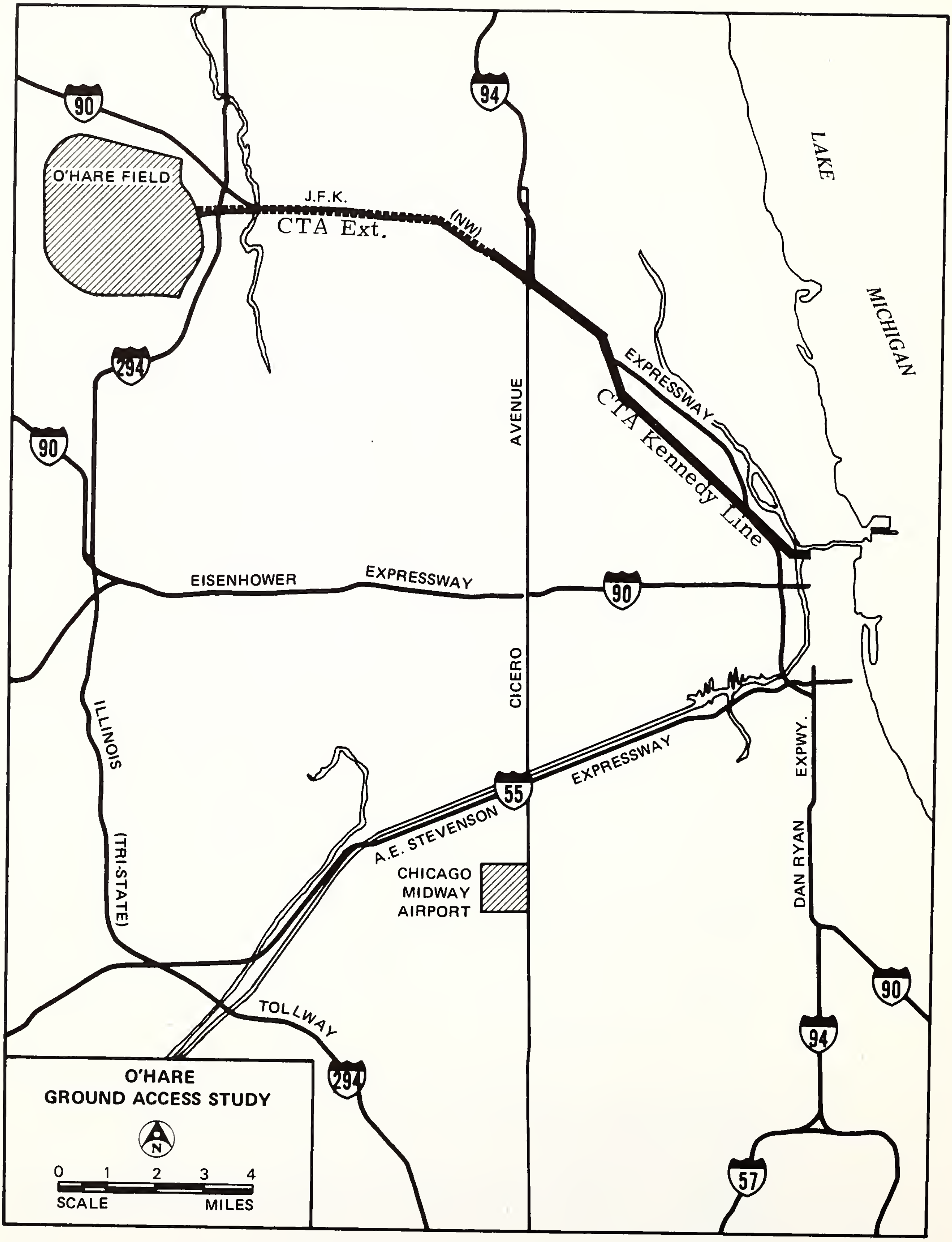


FIGURE III-1. CTA EXTENSION TO O'HARE

DESCRIPTIONS OF TESTED ALTERNATIVES

The four O'Hare Airport access alternatives tested are rail systems, each of which includes an extension to the existing CTA Milwaukee Service rapid transit line which now ends at Jefferson Park station. The alternatives differ in their approach to CBD distribution, and in the inclusion by some of parallel railroad right-of-way usage for express service between the CBD and Jefferson Park.

The four alternative systems are the following:

- Alternative #1 -- CTA Extension/Distributor System.
- Alternative #2 -- CTA/C&NW/Distributor System.
- Alternative #4* -- CTA Extension.
- Alternative #5 -- CTA/C&NW Terminal.

The alternative systems will be discussed separately.

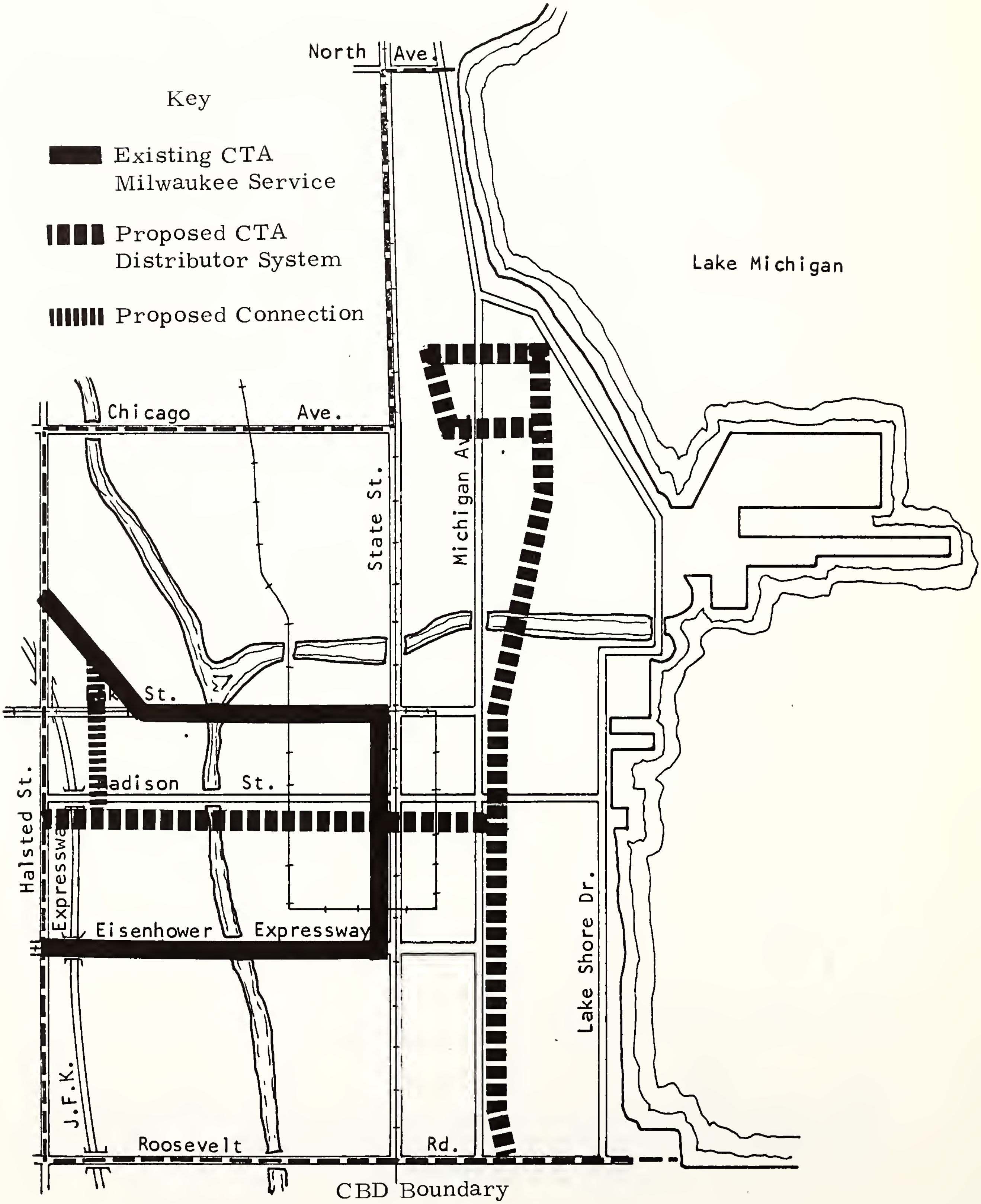
Alternative #1 -- CTA Extension/Distributor System (Figures III-1 and III-2)

In this alternative, a direct tunnel connection would be provided in the downtown area between the Milwaukee Avenue Service of the CTA and the proposed Distributor System. The tunnel would run beneath Des Plaines Street between Monroe and Hubbard Streets. Also, the CTA would be extended from Jefferson Park to O'Hare Airport, running within the median of the Kennedy Expressway. It has been assumed that special airport trains would make stops at specific stations in the CBD, and travel non-stop to Jefferson Park station. These premium fare airport trains would

*The numbers designating discussed alternatives remain consistent with previous memoranda and reports, in which additional alternatives (absent from this section) were described.

FIGURE III-2

CTA EXTENSION/DISTRIBUTCR SYSTEM
-CBD Distribution-



travel between conventional Milwaukee Service trains, which would themselves make all regular stops, but not necessarily travel to the airport. Local service trains might terminate in a new station at River Road, for example.

The connection between an airport access system and the proposed Distributor System would permit direct airport service from several significant portions of downtown Chicago. Thus, the Near Northside (Gold Coast) area, the Prudential Center (which could also become a CBD satellite airport terminal), and the hotel area facing the lake on South Michigan Avenue, for example, would each be provided direct airport access. As the Loop would be bisected by the Distributor System, nearly all important hotels and principal buildings would be within two or three blocks of the airport service.

Line-haul running times for both premium fare and local service trains would be similar, as both trains use essentially the same two-track right-of-way. Based on existing CTA vehicle performance characteristics, the running time to O'Hare Airport, via the tunnel connection, from the proposed Distributor System station at Monroe and Clinton Streets, would be approximately 31 to 32 minutes, including stops to cover the 17.2-mile distance. Running time to the airport from the Lake Street station would be similar.

Local service trains would be conventional CTA vehicles. The premium fare, non-stop airport trains for this alternative would be fitted with baggage carrying facilities located near doors for the convenience of airport passengers who hand-carry luggage on board. As a possible future improvement, special baggage check-in facilities could be made available at a downtown airport service terminal, and the trains could be fitted with

a form of palletized luggage carriers for rapid luggage dispatching to the appropriate airline terminals at the airport. However, this aspect has not been explored in this phase of the study.

Premium service trains would be composed of high performance CTA-type cars with conventional third rail power. Exterior dimensions would conform to CTA vehicle clearances. Interior appointments would provide slightly larger sitting room than on conventional mass transit equipment, with special sound absorbing insulation for a quiet ride. The cars would be fully air-conditioned.

The fare structure proposed for such a system would be similar to existing fares for competing modes. Premium fare service, for example, may be fixed at the \$1.50 to \$2.25 range one way, while the local service fare may be in the \$.60 to \$.85 range, one way.

Various alternatives for operational schemes would be available. For example, as extensive CBD distribution for local airport trains would not be of great consequence, one scheme would operate all local trains only on the Dearborn Street line, similar to current Milwaukee Service. Premium fare service, however, may use only the Distributor System for CBD distribution.

Both services would make stops at Jefferson Park, local trains providing "A" and "B" service stops as at present, and premium fare service making no stops up to Jefferson Park. If intermediate stations between Jefferson Park and O'Hare are constructed at River Road and Harlem Avenue, for example, the first of every three local service trains could reverse at O'Hare, the second at River Road, and the third at Jefferson Park, while Harlem Avenue could be considered either an "A" or "B" station. Premium fare service would make no stops between Jefferson Park and O'Hare.

A 15-minute service headway for premium service trains during rush hour periods would probably be adequate. On the basis of an existing 3-minute average rush hour headway to Jefferson Park, every third local service train reversing at the airport would provide 9-minute headways.

Alternative #2 -- CTA/C&NW/Distributor System (Figures III-3, and III-4)

In Alternative 2, the C&NW right-of-way would be utilized between the downtown area and Jefferson Park to provide a true, non-stop and express potential for premium service trains. The CTA would be extended beyond Jefferson Park as in Alternative 1. Physical connections would be provided between the C&NW right-of-way and CTA tracks in (a) the Jefferson Park area, and (b) west of the Chicago River into the proposed connection between the existing Milwaukee Service subway and the (Monroe Street) Distributor System.

As in Alternative 1, airport bound passengers would board this access service along the Distributor System, and travel directly to the airport via Jefferson Park station. The major difference in service is the ability of this alternative to provide high speed, non-stop service to the Jefferson Park area. All the benefits to Alternative 1 of the Distributor System would apply to this alternative as well, and all the advantages of the CTA extension also apply. Thus, CTA local service would exist to intermediate stations between Jefferson Park and O'Hare.

The Jefferson Park connection between C&NW and CTA systems would consist of track connecting the overhead C&NW right-of-way with the CTA tracks at ground level beyond the Jefferson Park station. The connection would be a 4 to 5 percent slope, single track, located between Milwaukee and Central Avenues, with its lower (CTA level) end headed north.

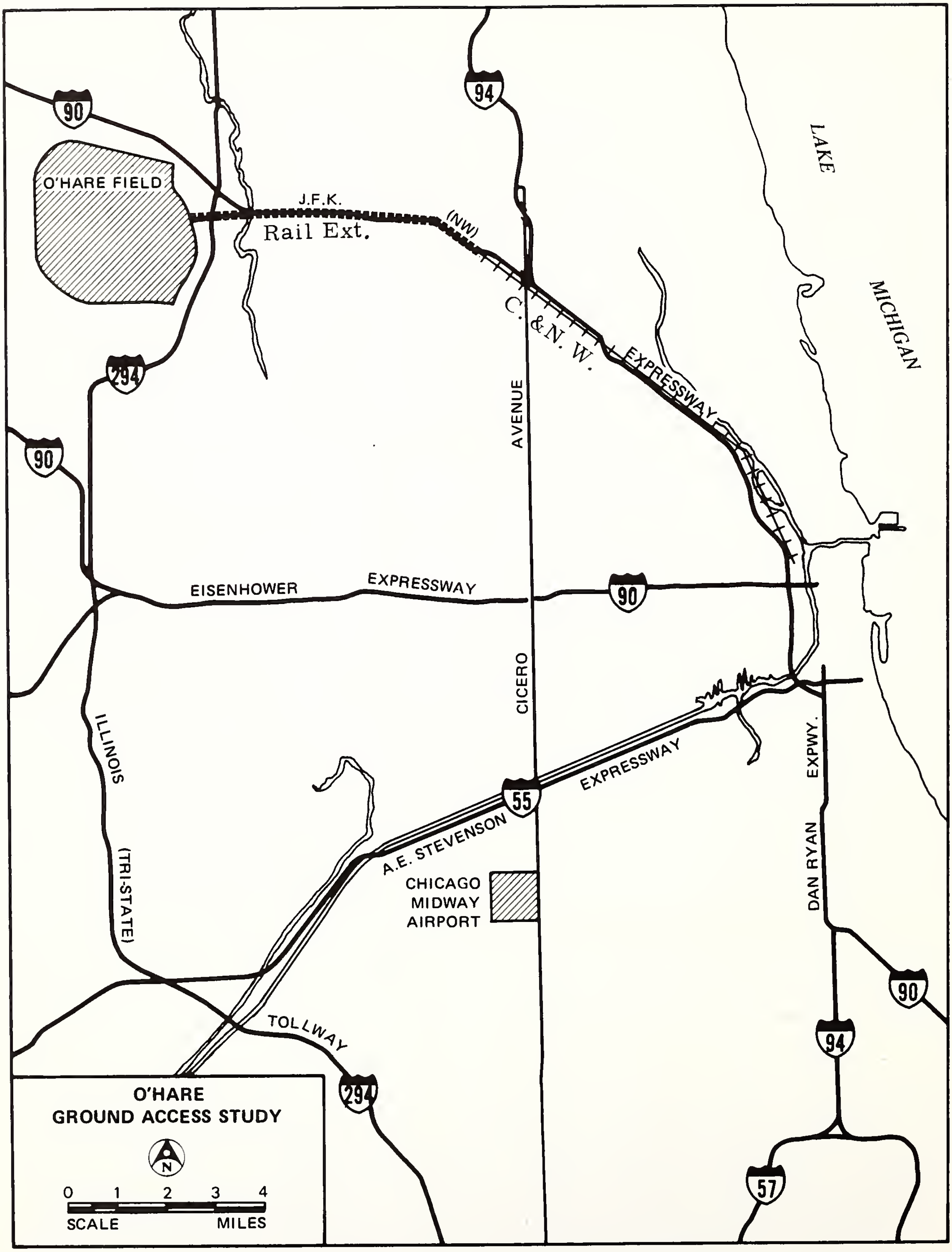
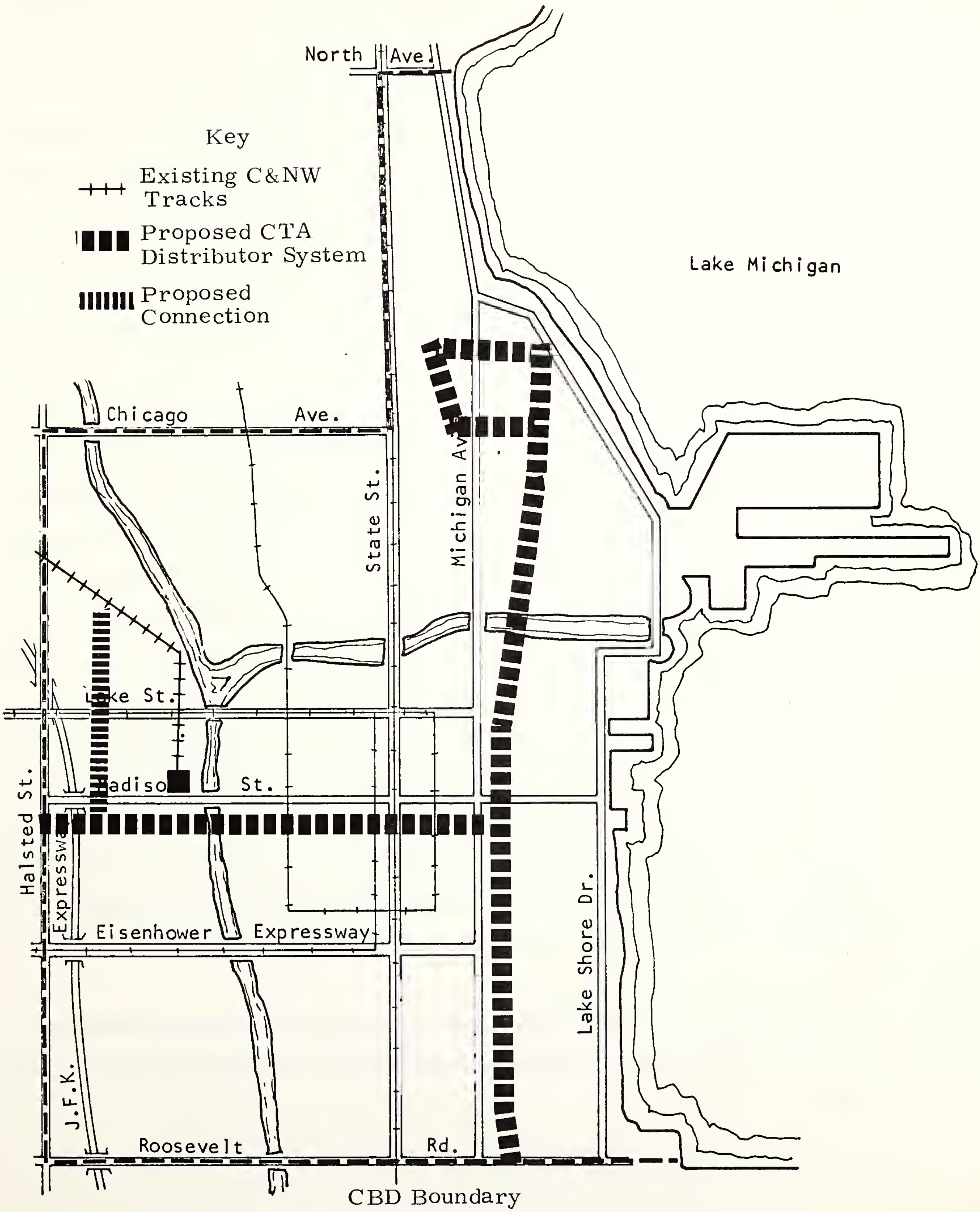


FIGURE III-3. CHICAGO AND NORTHWESTERN-JEFFERSON PARK-O'HARE

FIGURE III-4

CTA/C&NW/DISTRIBUTOR SYSTEM
-CBD Distribution-



Interlockings on the C&NW level may require a slight relocation of the C&NW Jefferson Park station, on the order of 300 to 500 feet.

The proposed C&NW-Distributor connection would be located in the vicinity of the proposed Milwaukee Service to Distributor System connection west of the Chicago River, in the Des Plaines, Jefferson, Kinzie Street area. This connection would consist of a single track beginning near the elevated C&NW overpass at the Orleans Street exit of the Kennedy Expressway, gradually dropping southward through street level, and ultimately meeting the connector subway tubes below street level in the vicinity of Lake and Randolph Streets.

The construction of a separate, two-track system may be necessary on the C&NW right-of-way between the downtown connection and Jefferson Park for this alternative. It has been confirmed that accommodation can be made on the right-of-way for additional track. Some questions of equipment compatibility exist between the existing C&NW railroad commuter trains and the proposed CTA type vehicles with regard to operations on a common track. Also, operating rule requirements and service interference may necessitate separate track construction. It is quite possible, however, that a sophisticated signal and control system may obviate the need for separate tracks, and solve potential compatibility and service capacity problems on joint use of a single right-of-way. (Cost estimates for both (a) separate track construction, and (b) alternative high capacity signals and controls are provided in Chapter VI.)

As in Alternative 1, Alternative 2 requires the CTA extension along the median of the Kennedy Expressway from Jefferson Park to O'Hare Airport.

Since the trains in nearly all respects must be compatible with existing CTA trains in order to use the Distributor Service track, the exterior dimensions of the vehicles for this alternative must match those of conventional CTA cars. Also, since the CBD distribution of stops and possible airport terminals would be the same for this alternative as for Alternative 1, interior vehicle appointments with respect to comfort, convenience, seating arrangements, and baggage accommodation would be identical to Alternative 1.

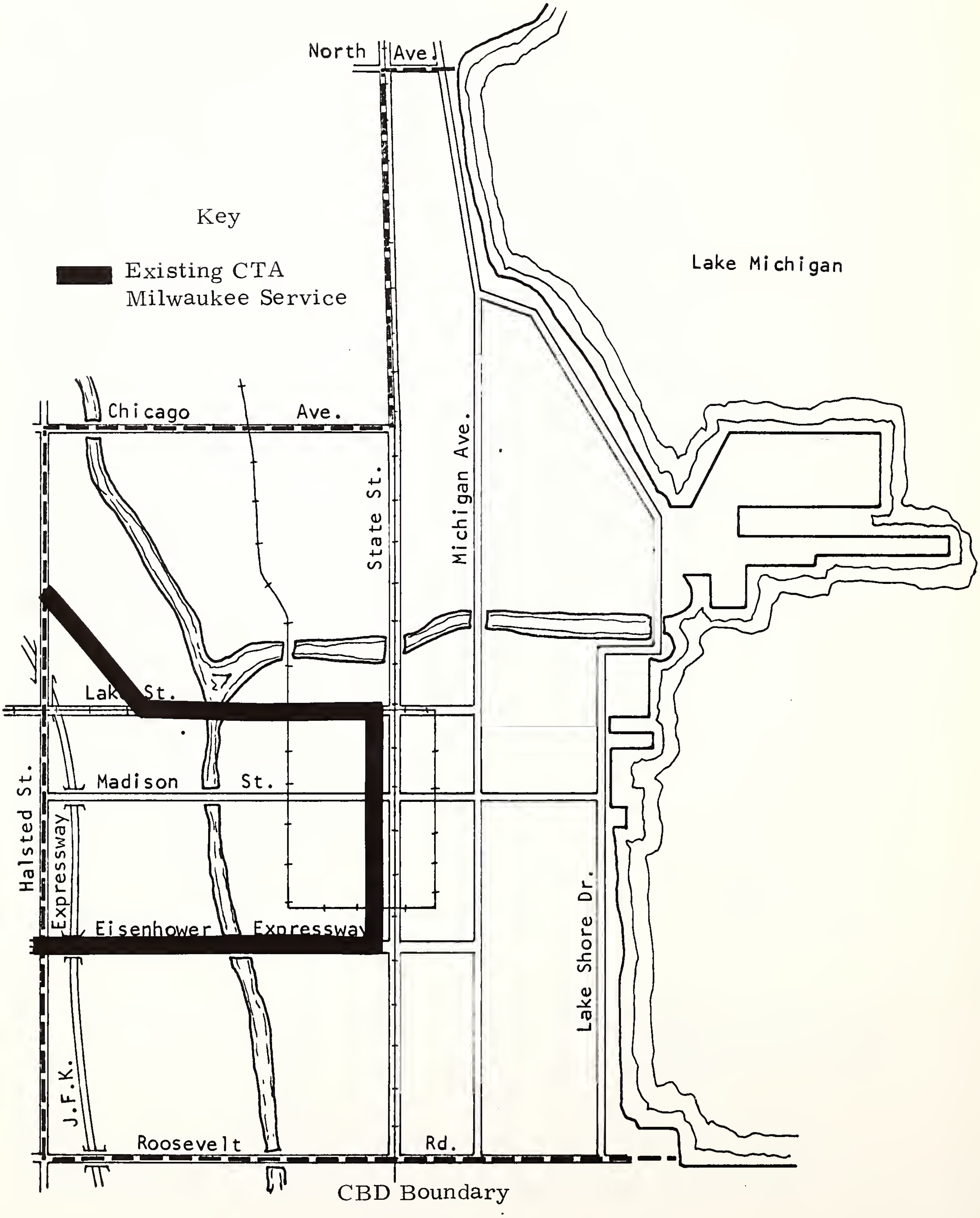
It is proposed that in order to minimize the construction cost of electrification for this service along the C&NW right-of-way, the vehicles derive their motive power from a hybrid electric power source: third rail when on CTA track, and from on-board gas turbine-driven alternators when on the C&NW right-of-way. Transfer of power would be made non-stop. (Prototype vehicles of this type are currently being built for the New York MTA, and following this, production models will be developed.) The high vehicle performance standard indicated for Alternative 1 would also be needed for this alternative.

Run-times for local service trains for this alternative would be similar to those in the previous alternative. For the premium service trains, however, true express trains could travel from the last CBD station to O'Hare in 21 to 22 minutes, depending upon the C&NW right-of-way speed limits assumed, and local service trains' interference beyond Jefferson Park.

Fare structures contemplated for this alternative would be similar to that of the previous one.

FIGURE III-5

CTA EXTENSION
-CBD Distribution-



Alternative #4 -- CTA Extension (Figures III-1 and III-5)

Access to O'Hare Airport in this alternative would be available through the extension of the CTA, from Jefferson Park to the airport, along the Kennedy Expressway median. The Distributor System and its connection is not included in the conception of this plan, and CBD access to the airport system would be obtained primarily through use of the existing Dearborn Subway.

Two service levels would be provided, essentially those described in Alternative #1 -- (a) premium fare, non-stop airport trains; and (b) local service, regular fare trains, some of which terminating at Jefferson Park, and others at River Road, for example.

Although conventional CTA cars, premium fare trains would have special seating accommodations and interior vehicle appointments consistent with the fare level. These cars would also have special baggage racks located near the doors. To accommodate passengers carrying baggage, a special turnstile would need to be provided in each CBD station, and escalator modification may be needed as well.

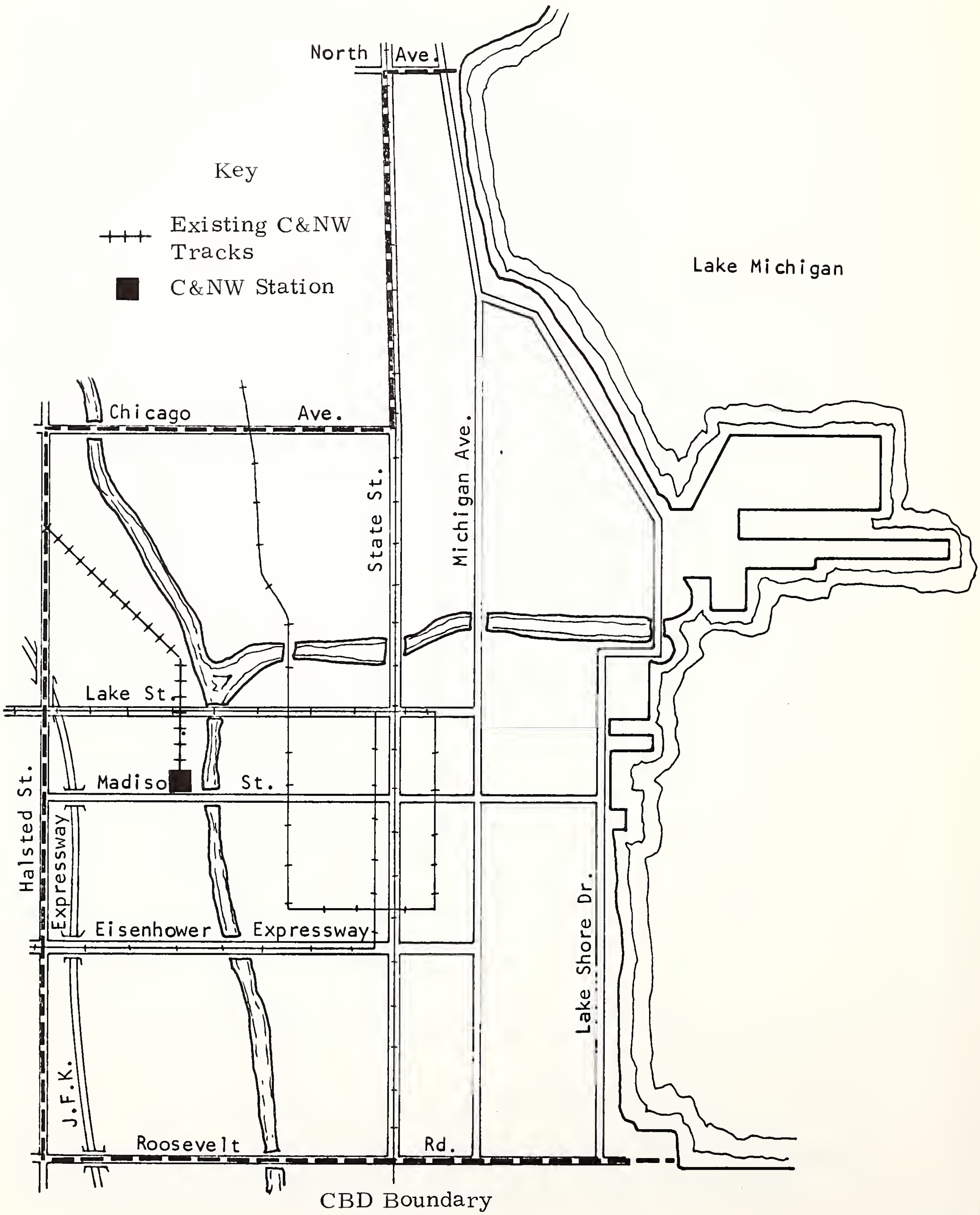
Several characteristics of the CTA Extension alternative would be similar to those in Alternative 1, i.e., fare structure, line-haul running time, service headway, and Jefferson Park-O'Hare operating scheme potential, for example.

Alternative #5 -- CTA/C&NW Terminal (Figures III-3 and III-6)

As in Alternatives 1, 2, and 4, the CTA would be extended along the Kennedy Expressway from Jefferson Park to O'Hare. For this alternative, the C&NW right-of-way would be used between downtown and Jefferson

FIGURE III-6

CTA EXTENSION/C&NW TERMINAL
-CBD Distribution-



Park, as in Alternative 2. However, the only downtown terminal for this airport system would be the C&NW Station.

Airport bound passengers could use the Distributor System or Lake-Dan Ryan service to gain access to the station nearest to C&NW station. A special pedestrian connection could be provided in this alternative for access to the proper railroad platform.

In the C&NW station, it is assumed that passengers would carry their own baggage to special airport trains fitted with convenient baggage facilities in each car, as in Alternatives 1 and 2. But there exists ample space in the C&NW station for ultimately providing baggage check-in and ticketing facilities operated by the airlines.

The special airport trains would travel non-stop to Jefferson Park, and then merge with the CTA extension out to the airport, also as in Alternatives 1 and 2. Thus, widespread Distributor System access would be utilized in this alternative, but with a transfer between the Distributor or Lake Service and the actual airport-bound vehicle. For other CBD areas, access to the terminal could be provided by taxi, auto, or shuttle bus service.

As in Alternative 2, CTA local Milwaukee/Dearborn service to existing "A" and "B" stations, and to intermediate stations between Jefferson Park and O'Hare, and to O'Hare itself, remains a possibility.

Many similarities between this alternative and Alternative 2 exist. The connection between CTA and C&NW tracks at Jefferson Park would be identical to that indicated for Alternative 2. C&NW right-of-way track construction/signals and controls upgrading alternatives are also the

same as for Alternative 2. And the proposed hybrid vehicle power system for premium fare service would also be the same.

Operating characteristics of both premium and local services could be similar to those described for the CTA/C&NW/Distributor alternative, with the exception of CBD distribution. Line-haul run time from C&NW Terminal to O'Hare would be on the order of 22 to 24 minutes, depending on assumed speed limits. Local service run times to the airport from the last CBD station, as in other alternatives, would be on the order of 31 to 32 minutes.

Fare structures would be similar to those previously described.

IV. CHARACTERISTICS AND IMPACTS OF ALTERNATIVE ACCESS SYSTEMS

In the previous chapter, a number of factors were identified which were included in the evaluation process of the alternative O'Hare-CBD access systems. A number of the factors or evaluation criteria such as patronage, revenue, and costs lend themselves to quantification, but several factors do not. It is the purpose of this chapter to describe, in mostly qualitative terms, the impacts of the alternative O'Hare-CBD systems under consideration as described in the previous chapter with respect to this latter group of non-quantifiable factors. Chapters V and VI will present the quantitative forecasts which were developed as part of the evaluation process.

The evaluation factors to be discussed in this chapter have been divided into three major categories. The first will discuss the qualitative aspects of the alternative systems' availability to airport-oriented travelers. The second will discuss the travel accommodations afforded airport-oriented travelers using the premium fare service. The third category will discuss the non-airport related impacts of the alternative systems.

AIRPORT-ORIENTED SERVICE AVAILABILITY

At the outset of this section, it should be pointed out that the availability of the alternative systems, i.e., the ease of access to the systems, have an obvious effect on patronage. This has been taken into consideration in developing the patronage forecasts contained in the next chapter. Nevertheless, there is a need to discuss the factors composing service availability to airport-oriented users on a more qualitative basis since it is not possible for the quantitative forecasts to fully represent the perceived level-of-service which each alternative would provide.

Air Passengers

A major consideration in evaluating that level-of-service which would be provided to air passengers is CBD distribution. One way to begin to evaluate the accessibility of system boarding points or terminals is to compute the average distance of 1983 air passenger CBD origin/destinations to the nearest station or terminal from which airport service would be available. This was done for each of the alternatives under consideration with the following results:[1/]

Alternative	Average Distance
CTA Extension/Distributor System (Alt. #1)	.3 mile
CTA Extension/C&NW/Distributor System (Alt. #2)	.3 mile
CTA Extension (Alt. #4)	.6 mile
CTA/C&NW Terminal (Alt. #5)	1.2 miles

An examination of computations made to obtain the above figures indicates that not only would the average distance to the C&NW terminal be over a mile, but also that the distribution of distances about the average value is such that very few air passengers would be within walking distance for a person with luggage. Thus, the great majority of air passengers would require a taxi to reach the C&NW terminal. On the other hand, the distribution for the CTA Extension, Alternative 4, is such that significant numbers of air passengers would be within walking distance of a station. It is mostly air passengers from the Gold Coast and southeast areas of the CBD who would require taxis to reach an airport station. Alternatives 1 and 2 would provide the most superior downtown distribution and consequently exhibit the lowest average distance. They would be accessible by walking for large numbers of air passengers throughout the CBD.

[1/] Average distances were also computed for single terminals at Union Station, Wolfe Point and the Prudential Center which were 1.2 miles, 1.2 miles, and .7 mile, respectively.

Other important factors in evaluating the level-of-service provided to air passengers concern non-CBD system access, and the number and difficulty of required transfers. The premium fare airport service provided by all four alternatives would stop at Jefferson Park, allowing convenient transfers from CTA local service. Due to the proximity of Jefferson Park to the airport and the existence of local CTA service to O'Hare, many air passengers in the areas to the north and northwest of the Chicago CBD would choose either to bypass Jefferson Park and go directly to the airport, or use the local CTA service from Jefferson Park. Thus, most of the air passengers using the premium fare airport service originating or terminating in non-CBD areas would come from areas to the south and west of the CBD. These riders would have to travel to the CBD by some other mode in order to board the airport service, regardless of which alternative access system is considered. For all of the alternatives except the CTA/C&NW Terminal, transfers would be possible from all CTA rapid transit lines without difficulty. Because the sole CBD boarding point for this alternative is located in the immediate vicinity of only one CTA rapid transit line, the Lake Service, transfers from CTA rapid transit service to airport service would be relatively difficult.

Airport Employees

Since all four alternatives include the provision of local CTA service to O'Hare, they all would serve airport employees in approximately the same manner. Employees boarding the system between the CBD and O'Hare would, of course, not require transfers to reach the airport. Most employees, however, would have to transfer from other CTA rapid transit or bus services to the local airport service in order to reach the airport. While it would be possible to send the local airport trains onto the Distributor System in Alternatives 4 and 5, the Consultant's analyses indicate that there would be little improvement in ease of transfer from

other rapid transit lines. This is due primarily to the fact that relatively convenient transfer points from all other CTA rapid transit lines to the Milwaukee service currently exist. Thus, all four alternatives would provide nearly identical service to the airport employee in terms of regional system access.

Airport Visitors

As noted in Chapter VI, airport visitors have been divided into two sub-groups for analysis purposes -- travel-related visitors and casual visitors. Since travel-related visitors accompany air passengers on their journey either to or from the airport, the same system availability characteristics apply to them as apply to air passengers. These were described above. It is assumed that casual visitors would use the local CTA service to reach the airport if they choose public transportation for their access/egress trips. Thus, the system availability characteristics which apply to airport employees apply to casual visitors as well. These also are described above.

TRAVEL ACCOMMODATIONS

Although subtle and difficult to quantify, the passenger comfort and convenience features which would be provided by the alternative systems under consideration on the premium fare services, would be very important in attracting and maintaining ridership. In general, all of the alternative premium fare services would provide essentially the same travel accommodations with only a few exceptions. These exceptions are noted in the point-by-point discussion of the travel accommodation features which follows.

Vehicle Comfort

For each alternative, it is assumed that the premium fare vehicles would be air-conditioned, have excellent noise insulation, and provide wide, cushioned seating. It is further assumed that there would be sufficient capacity to eliminate standees in all but a few seasonal peak periods. Regarding smoothness of ride, it is anticipated that the two alternatives utilizing portions of C&NW right-of-way may exhibit somewhat better ride quality; however, it is doubtful that the difference between these and conventional CTA vehicles would be very great as wheelbase and truck design would probably remain constant.

Baggage Storage

For each alternative, vehicles would be fitted with baggage carrying facilities located near the doors. With the possible exception of the CTA/C&NW Terminal alternative, where porters may be available at the C&NW Station, it is assumed that passengers would perform their own luggage loading and unloading from the airport trains. Local CTA service to O'Hare would provide no baggage accommodations in the trains.

Perceived Security

Because all alternative premium fare services would make limited stops and passenger crowding would be minimized accordingly, it is felt that all of the alternatives would provide a high degree of perceived passenger security.

Over 50 percent of the potential users in the CBD are air passengers who do not reside in the Chicago region. These persons are usually unfamiliar

with Chicago's public transportation system, and thus may tend to be somewhat concerned with their personal security when riding on public transportation vehicles. It is judged that the premium fare airport services would have a significant contrast with local CTA service to the airport, with regard to perceived security. Thus, this service would prove to be more attractive to the air passengers, especially those who are non-residents.

Station Dwell Times

Alternatives 1, 2, and 4 would have all stations on-line. Thus, dwell times would be limited making it somewhat difficult for passengers and their luggage to board and leave the vehicles. Dwell times would, however, be greater than standard CTA dwells, varying from 15 to 30 seconds (or possibly longer) depending on scheduling. Alternative No. 5, CTA/C&NW Terminal, which would use C&NW Station downtown would be capable of having dwell times there of several minutes or more, whenever necessary, since the airport trains here would be in a turnaround mode.

Station Modifications and Satellite Terminal Potential

It is assumed for all alternatives that the downtown stations, the Jefferson Park station, and the airport station would have modified turnstiles to permit convenient entry and departure by persons with baggage. Additionally, it is assumed that at least one escalator at these stations will be made wide enough to be used with ease and safety by persons carrying baggage.

With respect to the potential for ultimately providing a true downtown satellite terminal with baggage check-in and ticketing facilities,[1] the

[1] Although the alternatives evaluated in this report do not include a true downtown satellite terminal, the potential for such a terminal should nevertheless play a role in the evaluation process.

CTA Extension, Alternative 4, is the least desirable. A satellite terminal requires off-line boarding which this alternative could not provide in the CBD without major modifications. The CTA/C&NW terminal, Alternative 5, does provide off-line boarding and has ample available space for airline facilities; however, the terminal is not well located with respect to air passenger origins and destinations[1/] and might not attract enough ridership to warrant the provision of baggage check-in and ticketing facilities. Alternatives 1 and 2 via the distributor system do have the potential of providing a well situated satellite terminal. An off-line terminal could be constructed at the Prudential Center, coordinated with distributor construction to minimize costs. This location was the most accessible single boarding point location tested. [2/]

Perceived Travel Time

Although the actual travel time which each alternative would provide is clearly important and plays a major role in developing the patronage forecasts presented in Chapter V, perceived travel time is also very important. Perceived travel time may vary considerably from actual travel time particularly when waiting times are great or there are frequent stops. Of the alternatives under consideration, the two alternatives which utilize C&NW right-of-way (Alternatives 2 and 5) would probably minimize the ratio of perceived travel time to actual travel time since they would travel with only one stop (at Jefferson Park) from the CBD to O'Hare and would for most of the journey not be required to reduce speed due to other trains. Alternatives 1 and 4, on the other hand, which use CTA trackage exclusively can provide one stop service; but the airport train speeds

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[1/] See section in this chapter titled "Airport-Oriented Service Availability."

[2/] Forecasted average origin to terminal distance for Prudential Center was .7 mile as compared with 1.2 miles for Union Station, C&NW station and Wolfe Point.

would be sharply reduced due to the presence of local CTA trains on the same tracks making frequent stops (perhaps even bringing airport trains to a halt at points). Thus the perceived travel times for these alternatives may be considerably greater than actual travel times.

NON-AIRPORT RELATED IMPACTS

All of the alternative CBD-O'Hare fixed route rail systems under consideration would have important non-airport related impacts. It is the purpose of this section to identify these impacts qualitatively by type.

Non-Airport Related Ridership

All of the alternatives under consideration include the extension of Local CTA rapid transit service to O'Hare, primarily to serve airport employees. However, it is assumed that intermediate CTA stations would be constructed between Jefferson Park and O'Hare which would attract significant numbers of non-airport related riders, mostly commuters to the CBD. Quantitative forecasts of the extent to which non-airport related utilization of this extension would occur are included in the next chapter.

Intensification of Use of Existing Facilities

All four alternatives would intensify the use of the Kennedy-Milwaukee service rapid transit line via the local CTA airport service. Alternatives 1 and 4, however, would particularly intensify the usage of existing CTA facilities since they would utilize existing CTA tracks for the majority of the trip between the CBD and O'Hare. Alternatives 2 and 5 would intensify the utilization of the C&NW right-of-way between the CBD and Jefferson Park; however, new trackage would be required in the right-of-way.

The use of existing CTA Milwaukee Service downtown stations would be intensified by Alternative 4, and Alternative 5 would intensify the usage of the C&NW Station. Alternatives 1 and 2 would intensify the usage of the planned distributor system and its stations.

Right-of-Way Acquisition Requirements

Listed below by alternative are the new right-of-way requirements which would be needed to implement the systems under consideration. New right-of-way is defined as property not currently owned by a public agency, the City of Chicago, or the C&NW railroad.

- Alternative #1, CTA Extension/Distributor System -- Although a tunnel would be required in this alternative, it is anticipated that no additional right-of-way acquisition would be required.
- Alternative #2, CTA Extension/C&NW/Distributor System -- This alternative would require the possible acquisition of small parcels in several locations adjacent to existing C&NW right-of-way for supporting structures. Additionally, this alternative may require the possible demolition of existing warehouse structures abutting the C&NW right-of-way in one or two locations.
- Alternative #4, CTA Extension -- No additional right-of-way acquisition would be required for this alternative.
- Alternative #5, CTA/C&NW Terminal -- This alternative would require the same right-of-way acquisition as described for Alternative #2 above.

Traffic Disruptions During Construction

Listed below are the anticipated traffic disruptions due to construction anticipated as a result of the alternative systems under consideration.

- Alternative #1, CTA Extension/Distributor System -- This alternative would involve disruptions to Kennedy Expressway traffic, possibly severe at times, due to construction in the median between Jefferson Park and O'Hare. Additionally, traffic along Des Plaines Street between Hubbard Street and Monroe Street will be disrupted if the tunnel connection (approximately .6 mile in length) is constructed.
- Alternative #2, CTA Extension/C&NW/Distributor System -- This alternative would also involve disruptions to Kennedy Expressway traffic, possibly severe at times, due to construction in the median between Jefferson Park and O'Hare. Local traffic in the immediate vicinity, of structural support construction (for C&NW bridge erections) and building demolition sites would be disrupted during construction. Traffic on Grand Avenue, a significant CBD feeder, would require rerouting during construction of the C&NW-Distributor connection. Additionally, C&NW commuter trains may have to be operated at lower speeds during track construction work.
- Alternative #4, CTA Extension -- This alternative would also involve disruptions to Kennedy Expressway traffic, possibly severe at times due to construction in the highway median between Jefferson Park and O'Hare. No other disruptions are anticipated.
- Alternative #5, CTA/C&NW Terminal -- This alternative would involve disruptions to Kennedy Expressway traffic due to median construction between Jefferson Park and O'Hare, and disruptions of local traffic in the immediate vicinity of structural support construction and building demolition sites. Additionally, C&NW commuter trains may have to be operated at lower speeds during track construction.

Permanent Road Closings and Modifications

Alternatives 1, 4, and 5 would not require any permanent road closings or modifications; however, Alternative 2, CTA Extension/C&NW/ Distributor System, would involve several. These are as follows:

- The closing of Hubbard Street at North Des Plaines Street intersection with no significant commercial or commuting impact anticipated.

- The closing of the alley in the block between North Union Avenue and North Des Plaines Street with no significant commercial impact anticipated.
- The closing of North Des Plaines Street between Milwaukee Avenue and Hubbard Street with little impact on access to commercial enterprises in the area anticipated. In the vicinity of West Grand Avenue and Hubbard Street, this closing would have little impact on existing commercial enterprises.
- The depression of the North Union Avenue-West Grand Avenue intersection by six feet.

Environmental Impacts

After the completion of construction, it is anticipated that none of the alternative systems under consideration would create any adverse environmental impacts of a significant nature. No residential relocations would be required for any of the systems, and noise impacts would be minimal since all trains would be traveling in either existing right-of-ways presently used for commuter railroad or CTA rapid transit service, or in tunnels.

During construction, however, temporary impacts in the form of noise, dust, and perhaps vibration will occur in areas where construction will be required. In general these areas coincide with the areas previously identified where traffic disruptions would take place.

Each of the alternatives under consideration would divert travel from the existing highway modes thus reducing the emissions of pollutant gases. These reductions would take place at the expense of the energy required to operate the systems.

V. UTILIZATION PROJECTIONS OF ALTERNATIVE ACCESS SYSTEMS

This chapter presents the utilization projections which were developed as part of the evaluation process. Utilization of an access system is represented by the ridership or patronage which that system attracts. The airport access systems under consideration would attract, to varying degrees, airport-oriented riders in each of three categories -- air passengers, airport employees, and airport visitors. Separate sections in this chapter are devoted to presenting the patronage forecasts which were developed for each of these groups. In addition, the systems under consideration would have an impact on the ridership of existing commuter rail services and derive non-airport oriented ridership from not only commuter rail services but also existing CTA services and private auto usage as well. Thus sections in this chapter are also included which present preliminary forecasts of impacts on commuter rail services and estimates of non-airport oriented ridership.

AIR PASSENGER ACCESS MODE CHOICE FORECASTS

Background

Air passengers to and from O'Hare are currently using four modes for access -- private car, rental car, taxi, and limousine. In 1964 and 1969 surveys of air passengers indicated that these users were approximately equally divided between public and private modes (Table V-1). The purpose of this section is to predict any changes in this distribution if a fifth mode, i.e., a rapid rail service, is introduced. It was also required that the patronage differences for each of four alternative systems be estimated.

TABLE V-1

MODAL DISTRIBUTION FOR DEPARTING AIR PASSENGERS
1964 AND 1969

Mode	Percentage Distribution 1964	1969
Private Car	49.9	56.6
Rental Car	Not Indicated	6.0
Taxi	25.3	14.1
Limousine/Coach	18.7	13.8
Other, or Not Indicated	6.1	9.5
	100.0	100.0

Methodology

The mathematical techniques for estimating mode choice are generally binary in nature. This means a trip is either made by a public mode or a private mode. However, for this project it was important to have a multimodal technique which would distinguish between the patronage estimates of the rapid rail, taxi, and limousine modes. A restriction, however, was that the available data would not support the calibration of such a model. Several models were examined for their degree of applicability noting the above requirements (see Appendix A). After an extensive investigation it was decided that the airport access model calibrated for the Washington-Baltimore Airport Access Study could be used with reliability.

The data requirements for this model were a forecast of the air passenger demand in each of the districts defined in Chapter II, and the service characteristics to each of these districts for each alternative mode. The output from the model was a forecast of patronage on all modes from each district and summary estimates for each of the four major analysis areas.

- Central Business District
- Area beyond the CBD but within the city limits
- Area beyond the city limits but within the CATS cordon
- Area beyond the CATS cordon.

The air passenger forecasts and the procedure for obtaining them are described in Chapter II. The service characteristics for each of the alternative modes were obtained from several sources. The highway level of service characteristics were supplied by CATS from the Chicago area highway network. This was supplemented with the results of measured traveltime run between O'Hare and the Palmer House in

TABLE V-2

OBSERVED AND ESTIMATED MODE SPLIT FOR DEPARTING AIR PASSENGERS - 1969 1/

	Central Business District		Beyond CBD but Within City Limits	
	Percent Observed	Percent Estimated	Percent Observed	Percent Estimated
Private Car	11	11	53	52
Rental Car	5	4	12	11
Taxi	40	42	27	28
Limousine/Coach	42	43	8	9
	100	100	100	100

1/ This table is for business trips only. Observed distributions have been adjusted to account for survey bias. Definition of the CBD is given in Figure II-2.

downtown Chicago to obtain a weighted travel by hour of day.[1] The rapid transit travel times were also supplied by CATS and supplemented with data from CTA published schedules. Unpublished data from the Bureau of Engineering, City of Chicago, was also used in preparing travel times for some of the alternatives. Using these inputs the model was applied to the distribution of departing air passengers observed in 1969. The results indicate that, after adjusting the calibration constants, the model does replicate the observed mode choice of departing air passengers (see Table V-2).

A feature of the selected model is that the introduction of a new mode requires an estimate of how the potential users of this new mode will perceive its service characteristics. It was considered that service characteristics of any of the four alternative rapid rail systems would be approximated by the service characteristics of the existing coach service. The travel times to and from the CBD would be approximately the same, although access times to boarding points would be different. The frequency of service and the cost of service were also envisaged to be similar to the existing coach service. It therefore appeared reasonable to use the same calibration parameters for the rapid rail alternatives as the coach service.

The various service characteristics of the alternative modes are shown in Figure V-1. These characteristics were combined for each mode to give an estimate of the

- Total door-to-door travel time
- Total out-of-pocket costs.

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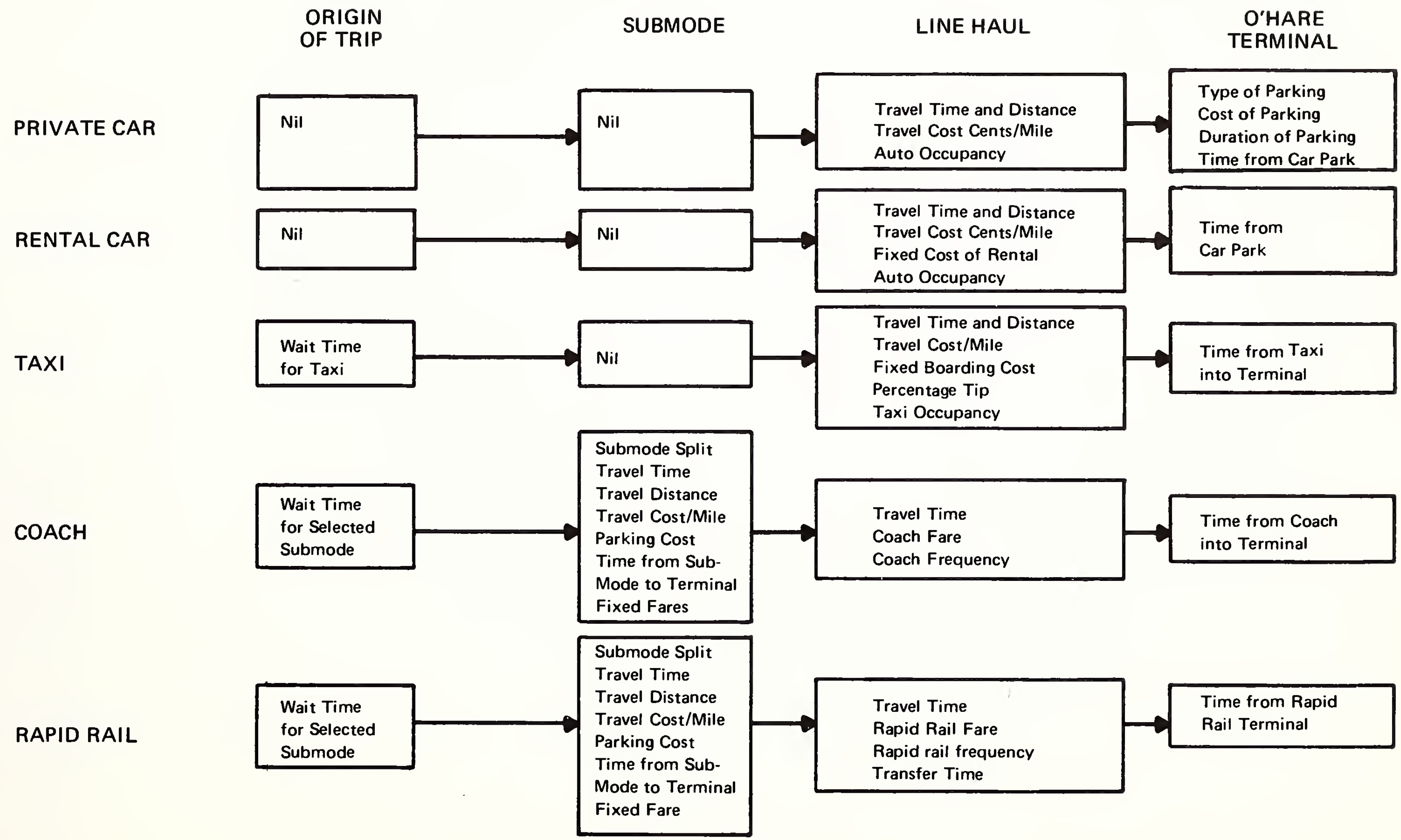
[1] CATS Research News, September-October 1968.

Figure V-1. Service Characteristics Considered in Mode Choice Model



Results

The previous section described the inputs to the air passenger mode choice model and the results obtained when applied to the distribution of 1969 air passengers. This section describes the results when the model is applied to the 1983 air passenger demand and O'Hare-CBD rail systems are introduced as alternative modes.

The projected distribution of air passenger demand at the 30 million enplanement was made using four major analysis areas (see Chapter II). Only two of these same areas were examined in the modal split forecasts. The remaining two areas were beyond the city limits of Chicago and have been neglected, because it was decided that they would not be influenced by introduction of a rapid rail service. incorrect assumption

The analysis consisted of three phases. The first was to estimate the modal share for each of four alternative rapid rail services. Each system providing a premium service with a fare of $2.25 and frequency of 10 minutes. The results indicated that the new systems would obtain between 21 percent and 36 percent of the market for air passengers to and from the CBD and between 5 percent and 8 percent for non-CBD air passengers. The exact share would depend on which alternative was selected (see Tables V-3 and V-4).

The simple CTA extension would attract 27 percent of air passengers from the CBD and 7 percent of non-CBD air passengers. This represents a total of 8,010 passengers on an average day. The CTA/Distributor system would attract 30 percent of CBD air passengers and 7 percent of non-CBD air passengers. This represents a total of 8,760 passengers on an average day. The remaining two C&NW alternatives would attract 21 percent of CBD air passengers without the Distributor connection and 36 percent with the connection. The effect on non-CBD air passengers

TABLE V-3

MODE SPLIT FOR CBD AIR PASSENGERS 1983
WITH ALTERNATIVE RAPID RAIL SERVICES

		Alternative[1/]			
Mode	1969 (%)	CTA Extension (%)	CTA/ Distributor (%)	CTA/C&NW Terminal (%)	CTA/C&NW/ Distributor (%)
Private Car	12	8	8	9	7
Rental Car	5	3	3	3	3
Taxi	41	32	30	34	28
Limousine/Coach	42	30	28	33	26
Rapid Rail	--	27	31	21	36
	100	100	100	100	100

[1/] Premium service conditions with fare of $2.25 and 10 minute headways.

TABLE V-4

MODE SPLIT FOR NON-CBD AIR PASSENGERS 1983
WITH ALTERNATIVE RAPID RAIL SERVICES

		Alternative[1/]			
Mode	1969 (%)	CTA Extension (%)	CTA/ Distributor (%)	CTA/C&NW Terminal (%)	CTA/C&NW/ Distributor (%)
Private Car	53	49	49	49	49
Rental Car	12	10	10	10	10
Taxi	28	28	28	29	28
Limousine/Coach	7	5	5	6	4
Rapid Rail	-	7	7	5	8
	100	100	100	100	100

[1/] Premium service condition with fare of $2.25 and 10 minute headway.

TABLE V-5

TOTAL NUMBER OF AIR PASSENGERS USING
RAPID RAIL ALTERNATIVE ON AVERAGE DAY 1983

Alternative	Total Number of Rapid Rail Passengers			
	Premium Service		Maximum Revenue Fare[1/]	
CTA/Distributor System (Alternative 1)	8,420	($2.25)	12,720	($1.70)
CTA/C&NW/Distributor System (Alternative 2)	10,440	($2.25)	13,990	($1.80)
CTA Extension (Alternative 4)	8,010	($2.25)	12,300	($1.60)
CTA/C&NW Terminal (Alternative 5)	6,150	($2.25)	11,280	($1.50)

[1/] Maximum revenue fares shown in brackets.

would be 8 percent and 5 percent, respectively. The corresponding passenger volumes on an average day are 6,150 and 10,440, respectively. (See Table V-5.)

The second phase was to estimate the sensitivity of the previous estimates to changes in fares and changes in frequency of service. Fares were varied from \$1.50 to \$2.25, while the service headways were held constant at 10 minutes. The results indicated that for each 25 cent decrease in fare there was an increase of approximately 6 percent in patronage for CBD passengers (see Figure V-2). From these curves it was possible to estimate the point of maximum annual revenue. This occurs when the number of passengers times the fare paid is a maximum. The results indicate the maximum revenue fare for CBD air passengers ranges from \$1.50 for the CTA/C&NW alternative to \$1.80 for CTA/C&NW/Distributor alternative. The corresponding patronage estimates are shown in Table V-5.

The frequency of service was also varied while the fare was held constant at \$2.25. Headways of 10 minutes, 15 minutes, and 20 minutes were estimated for all alternatives; however, only minor changes were observed in the patronage forecasts (see Figure V-2).

The third phase was to investigate the impact of eliminating the existing coach service to the CBD. The results indicated that a rapid rail service would gain another 13 percent of the total market for the two alternatives using the distributor system, and approximately 10 percent for the other alternatives. The remaining coach riders who did not transfer to the rapid rail service would divert to the other modes such as taxi. An estimate of these changes in terms of average daily passengers is given in Table V-6.

TABLE V-6

IMPACT OF ELIMINATING EXISTING COACH SERVICE ON 1983 CBD DEMAND

Alternative	Average Daily Patronage[1/] Coach	No Coach	Percent Change
CTA /Distributor System (Alternative 1)	7,600	10,640	40
CTA/C&NW Distributor System (Alternative 2)	9,120	12,420	36
CTA Extension (Alternative 4)	6,850	9,650	41
CTA/C&NW Terminal (Alternative 5)	5,320	7,850	48

1/ Table assumes a fare of $2.25 and 10 minute headways on rapid rail service. Coach service is frequently referred to as limousine service.

would be 8 percent and 5 percent, respectively. The corresponding passenger volumes on an average day are 6,150 and 10,440, respectively. (See Table V-5.)

The second phase was to estimate the sensitivity of the previous estimates to changes in fares and changes in frequency of service. Fares were varied from \$1.50 to \$2.25, while the service headways were held constant at 10 minutes. The results indicated that for each 25 cent decrease in fare there was an increase of approximately 6 percent in patronage for CBD passengers (see Figure V-2). From these curves it was possible to estimate the point of maximum annual revenue. This occurs when the number of passengers times the fare paid is a maximum. The results indicate the maximum revenue fare for CBD air passengers ranges from \$1.50 for the CTA/C&NW alternative to \$1.80 for CTA/C&NW/Distributor alternative. The corresponding patronage estimates are shown in Table V-5.

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The third phase was to investigate the impact of eliminating the existing coach service to the CBD. The results indicated that a rapid rail service would gain another 13 percent of the total market for the two alternatives using the distributor system, and approximately 10 percent for the other alternatives. The remaining coach riders who did not transfer to the rapid rail service would divert to the other modes such as taxi. An estimate of these changes in terms of average daily passengers is given in Table V-6.

TABLE V-6

IMPACT OF ELIMINATING EXISTING COACH SERVICE ON 1983 CBD DEMAND

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[1/] Table assumes a fare of $2.25 and 10 minute headways on rapid rail service. Coach service is frequently referred to as limousine service.

Fig. V-2 Sensitivity of CBD Transit Forecasts

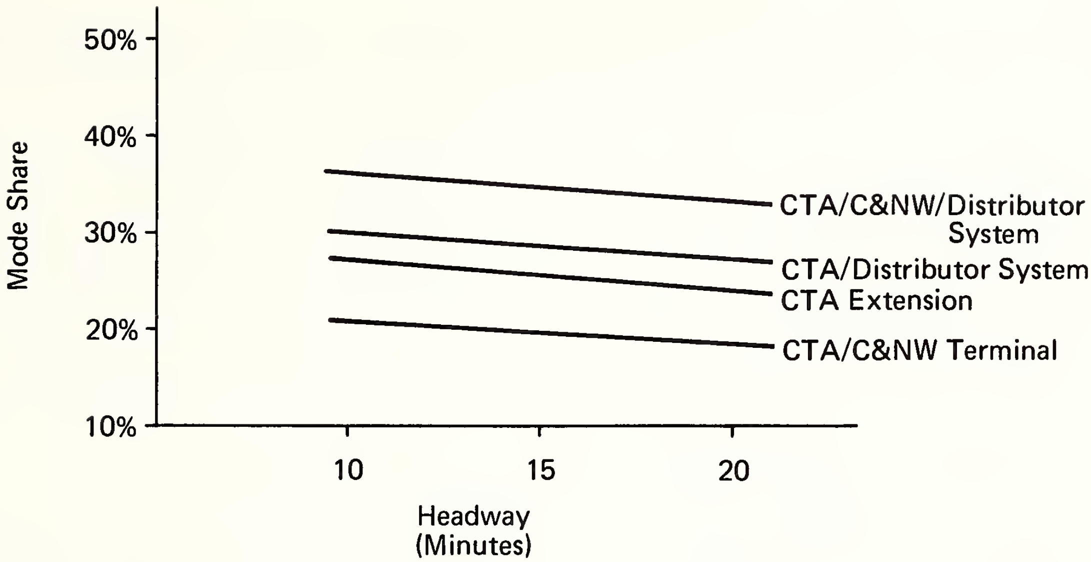
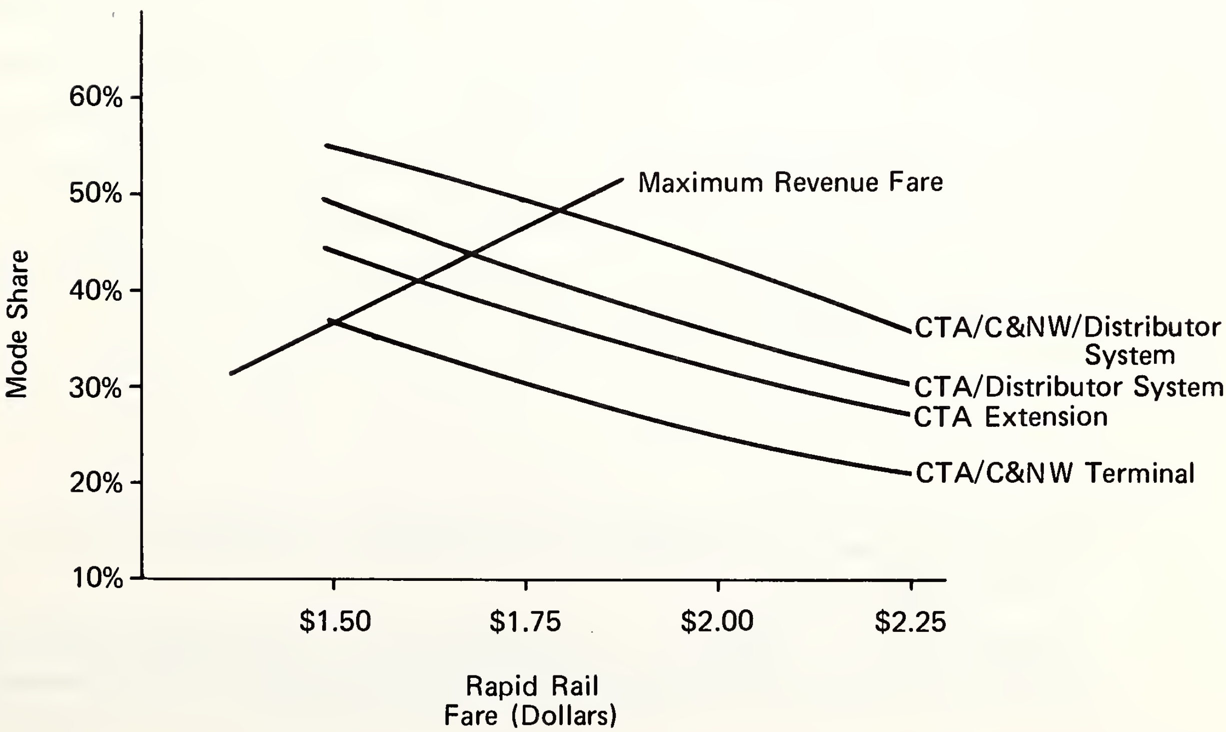


Fig. V-3 Sensitivity of CBD Transit Forecasts



Summary

Four alternative rapid rail services between O'Hare and the CBD were examined for their attractiveness to air passengers departing from or originating in the City of Chicago. The analysis indicated that for premium service conditions the CTA/C&NW/Distributor service attracted the greatest number of air passengers with 10,440 passengers on an average day. The remaining alternatives in order of patronage were the CTA/Distributor service with 8,420 passengers, the CTA service with 8,010 passengers, and the C&NW service with 6,150 passengers.

The sensitivity of these forecasts to differing fares was significant. However, the sensitivity to the frequency of service was shown to be insignificant. This observation may differ from an intuitive assessment; however, it has been supported in other studies.[1/]

Estimates were not made of the extent to which air passengers would utilize local CTA service instead of premium fare service if both services were provided to the airport. While such utilization can be expected to occur, especially among Chicago residents, the Consultant feels that the characteristics provided by the premium fare service are necessary to attract to the system the non-resident air passengers travelling on business. Such travellers comprise the majority of air passengers whose local origin-destination is in the CBD.

[1/] Washington-Baltimore Airport Access Study, Washington Council of Governments, 1971.

DeNeufville, R.; Koller, F., and Skinner, R., "A Survey of New York City Airport Limousine Service: A Demand Analysis," HRB Record 348.

AIRPORT EMPLOYEE ACCESS MODE CHOICE FORECASTS

Background

The 1968 Airport Employee Survey which was conducted at O'Hare indicated that only about 1 percent of the airport's employees used public transportation for access to their jobs. The O'Hare Express bus service has increased the percentage to about 3.5 percent.[1/] It is the purpose of this section to present estimates of the extent to which airport employees would utilize the alternative CBD-O'Hare rail systems under consideration for their work trips to O'Hare. An employee might use the alternative systems either for the entire length of his work trip for as just one segment of a multi-modal work trip, depending on his residential location.

Before describing the methodology which was employed in forecasting employee access mode choice, it will be useful to reiterate the type of service which would be provided to the airport employee by each alternative:

- Alternative #1, CTA Extension/Distributor System -- Would provide express and local CTA trains between O'Hare and the planned Distributor system stations. Express trains, however, would be aimed at serving the air passenger and charge a premium fare so that it is assumed the airport employees would use the local CTA trains.
- Alternative #2, CTA Extension/C&NW/Distributor System -- Would provide express, premium fare trains running between O'Hare and the planned Distributor stations utilizing a portion of the C&NW right-of-way. Local CTA trains would, however, also operate between O'Hare and the downtown using existing CTA Milwaukee Service tracks. It is assumed that employees would use the local service because of its lower fare and superior collection/distributer characteristics with respect

[1/] Based on the 1970 O'Hare Express passenger survey and CTA ridership records.

to employee residential locations. Thus the service provided to the airport employee in this alternative is assumed to be the same as the service provided by Alternative #1 to employees.

- Alternative #4, CTA Extension -- Would serve O'Hare by extending the CTA's Milwaukee Service to the airport. Although limited stop special trains with premium fares might be provided, it is assumed that airport employees would use local trains to reach O'Hare with their lower fares. Downtown distribution and collection would be via existing Milwaukee Service stations.

- Alternative #5, CTA Extension/C&NW Terminal -- Would provide express premium fare service between O'Hare and C&NW station by utilizing a CTA extension and C&NW right-of-way between Jefferson Park and C&NW station. However, CTA Milwaukee Service would also be extended to O'Hare, [1/] and it is assumed that employees would use this service. Thus airport employees would be served by essentially identical service in Alternatives #4 and #5.

Methodology

In the preceding discussion it was shown that each alternative would provide airport employees with essentially the same service, i.e., local, CTA rapid transit service. The only difference between alternatives which is possibly significant concerns downtown distribution. Alternatives 1 and 2 would utilize the proposed CTA Distributor system while Alternatives 4 and 5 would rely on existing Milwaukee Service stations for collection and distribution. Four factors, however, combine to reduce the importance of this difference: (1) only 1 percent of O'Hare's employees reside in the CBD; (2) transfers from other rapid transit lines such as the Dan Ryan or Ravenswood service would still be required with the Distributor system to reach O'Hare; (3) transfer times to the Milwaukee Service would only marginally improve by running Milwaukee Service trains

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[1/] Not necessarily every train, however, would go to O'Hare.

through the Distributor system; and finally (4) scheduling may permit only the special premium fare airport trains to use the Distributor system. Thus, a connection to the proposed Distributor system will do little to improve rapid transit service for airport employees, either in terms of reduced travel time or reduced transfers. As a consequence, the four access alternatives can be effectively reduced to one alternative for the purpose of forecasting airport employee patronage.

Since insufficient data is available for calibrating an airport employee mode choice model, airport employee mode choice forecasts were made using a work trip auto-rapid transit model calibrated by the Chicago Area Transportation Study (CATS);[1/] thus assuming that in the future airport employees will travel to work either by auto or transit. The particular model form used is described in Appendix B. The model was applied at a four square mile zonal level using as input the transit travel time and cost, the auto travel time and cost, and the distance between the residence zone and O'Hare.

Auto and transit travel times for the model were supplied by CATS. The transit travel times assume the existence of the Distributor system and were modified somewhat to agree with the Consultant's estimate of possible running speeds between O'Hare and the CBD. The auto travel times supplied were off-peak and were adjusted somewhat to account for peaking as described in the next section. Auto costs were assessed in a manner compatible with the method used in calibration. A range of transit fares were tested.

1/ Unpublished CATS research.

Results

Using this mode choice model, a number of forecasts were prepared to reflect possible variations in the various input variables. In general, the forecasted percentage by rapid transit via an extension from Jefferson Park to O'Hare was between 15 percent and 20 percent. Summarized below are the results of the sensitivity analyses performed.

- Auto Travel Times -- As noted previously, the auto travel times supplied by CATS were off-peak. However, an analysis of airport employee's starting and quitting times as determined in the 1968 employee survey reveals that approximately 50 percent of O'Hare's employee access/egress trips occur during peak periods. As a consequence, forecasts were developed using not only off-peak auto travel times, but also by using off-peak travel times plus a percentage of off-peak travel times, assessed at all zone-to-airport combinations. Increasing auto travel times from off-peak to off-peak plus 20 percent, increased the forecasted mode share of rapid transit from 16 percent to 18.4 percent.[1/] It should be noted that since only 50 percent of the airport's employees travel in peak periods a 20 percent increase in auto travel times for all employees is roughly equivalent to assuming that the travel times of employees traveling in peak periods are 40 percent higher than off-peak travel times.

- Rapid Transit Travel Times -- Although total transit travel times would not vary significantly due to peaking, they would depend on the headways of local trains which would serve O'Hare. As a consequence, employee mode choice forecasts were prepared assuming different headways for local trains serving O'Hare. As headways increase from 6 minutes to 10 minutes and then 20 minutes, the forecasted mode shares of transit are 19.3 percent, 18.3 percent, and 15.9 percent, respectively.[2/]

[1/] Assuming at total transit fare of $.80 and 6 minute headways.

[2/] Assuming a total rapid transit fare of $.70 and auto travel times of off-peak plus 15 percent.

- Rapid Transit Fares -- At this stage in the analysis it is difficult to anticipate the exact fare which would be charged for local, CTA rapid transit service to O'Hare. The total transit fare for airport access potentially can be divided into three parts -- (1) the base CTA fare, currently $.45; (2) the bus to rapid transit transfer charge, $.10; and (3) an airport station surcharge as used in Cleveland. Parts (1) and (3) would be paid by all employees using the rapid transit service, but Part (2) would be paid by only those employees who use a bus for rapid transit station access/egress. At present the fare to O'Hare via the O'Hare Express bus service is $.75. In general, it was assumed for the patronage forecasts that employees would pay a total fare of $.70 to $.80. Decreasing the total fare from $.80 to $.55 however would result in increasing the rapid transit mode share from 16 percent to 19.6 percent. Good Assump.

Over the ranges tested, the sensitivity analyses which were performed indicate that the forecasted utilization of an O'Hare-CBD rapid transit service by employees is relatively insensitive to changes in the travel time or fare level assumptions. It seems likely that the changes in the forecasts due to different assumptions concerning input parameters are smaller than the probable error of the entire modelling procedure. Consequently, the results summarized in Table V-7 assume a single fare level of $.70 and a single auto travel time adjustment for peaking (off-peak times plus 15%). These assumptions would be the same for any local rapid transit service provided in any of the four alternative systems under consideration. It is possible, however, that headways might vary between alternative systems so that separate forecasts are reported in Table V-7 for three different headway assumptions.

It should be noted that the forecasts of usage of a rapid transit service to O'Hare by employees indicate that approximately 52 percent of the employees would board at downtown stations or transfer at downtown stations so that they would ride the entire service from the CBD to O'Hare. Approximately

TABLE V-7

FORECASTED 1983 USAGE OF O'HARE-CBD RAPID TRANSIT SERVICE BY AIRPORT EMPLOYEES

Headway of Local CTA Trains to O'Hare	Percentage of Employees Using Rapid Transit For Access/Egress[1/]	1983 Average Daily One-Way Person Trips Using Rapid Transit	1983 One-Way Person Trips Using Rapid Transit
6 minutes	19.3%	7,600	2,770,000
10 minutes	18.3%	7,200	2,630,000
20 minutes	15.9%	6,400	2,290,000

[1/] Assumes a total transit fare of $.70 and auto travel times of off-peak plus 15%.

25 percent would board at stations between Grand and Jefferson Park, and approximately 23 percent would board at intermediate stations between Jefferson Park and O'Hare.

AIRPORT VISITOR ACCESS DEMAND

As noted at the beginning of Chapter II, airport visitors can be divided into two general sub-groups -- travel-related visitors (TRV) and casual visitors. The extent to which each of these sub-groups would utilize the alternative systems under consideration must be estimated separately.

Travel-Related Visitors (TRV)

The 1969 air passenger survey obtained data which was used to determine the figures shown in Table V-8. These figures indicate that there is a relationship between the number of travel-related visitors associated with an air passenger and the access mode choice of the air passenger. In general, the "public" modes for which fares are charged carry relatively few travel-related visitors while the private auto carries a relatively large number of travel-related visitors. In order to forecast the extent to which travel-related visitors would utilize the alternative O'Hare-CBD systems under consideration, this empirical relationship was used, thus hypothesizing that the number and distribution of travel-related visitors is dependent on the distribution and access mode choice of air passengers. While the figures of Table V-8 would be suitable to estimate the number of TRV using existing access modes, they cannot be used directly for new modes. Nevertheless, they did provide a guide for selecting the proper factor for the alternatives tested. One would expect the TRV-to-air passenger ratio for fixed route rail access systems to be similar to the observed ratios of the "public" modes rather than private auto. Of the

TABLE V-8

1969 TRAVEL-RELATED VISITORS PER PASSENGER
BY ACCESS MODE

Mode	Travel-Related Visitors Per Air Passenger[1/]
Airport Limousine/Coach	0.064
Taxicab	0.077
Private Auto	0.711
Rental Auto	0.169
Other	0.220

Source: Based on 1969 survey of departing air passengers on Wednesday, April 16.

[1/] Each travel-related visitor makes two access trips (one to the airport and one from) whereas each air passenger makes only one.

"public" modes, the level of service which would be provided by the rail systems would probably be most similar to the airport bus, provided a premium fare is charged. Thus, for forecasting the number of TRV who would utilize a rail access system with a premium fare, the observed TRV-to-air passenger ratio (.064) for airport bus was used. As a check it can be noted that for rail services without premium fare, one would expect a somewhat higher ratio than .064. In Cleveland where a non-premium fare is charged for rail access to the airport from the downtown, a ratio of .090 TRV per air passenger has been observed.[1/] This value also appears reasonable in light of Chicago data[2/] which indicates the O'Hare express bus service generates .093 TRV per air passenger.

Table V-9 summarizes the forecasts of TRV which were made.

Casual Visitors

Unlike the situation with travel-related visitors, very little data is available concerning either the numbers or access mode choice of airport casual visitors. No information has been collected at O'Hare in this area. Nevertheless there is a need to forecast the numbers of casual visitors who would use the alternative rail access systems under consideration since these may affect substantially the economic and financial evaluations by virture of the revenue produced.

In Cleveland a ratio of .146 casual visitors per air passenger[3/] on the airport rapid transit line was observed in 1969.[4/] Since casual visitors

[1/] Cleveland-Hopkins Airport Access Study, Survey Results, June 1970.

[2/] Stanford Research Institute, Benefit-Cost Survey: Chicago O'Hare Express Transit Project, September 1970.

[3/] Each casual visitor makes two access trips (one to the airport and one from) whereas each air passenger makes only one.

[4/] Cleveland-Hopkins Airport Access Study, Survey Results, June 1970.

TABLE V-9

FORECASTED 1983 AVERAGE DAILY TRAVEL-RELATED VISITORS BY ALTERNATIVE[1/]

Alternative	Average Daily Travel Related Visitors (TRV)
CTA Extension/Distributor System (Alternative #1)	1,600
CTA Extension/C&NW/Distributor System (Alternative #2)	1,800
CTA Extension (Alternative #4)	1,600
CTA Extension/C&NW Terminal (Alternative #5)	1,400

[1/] It is assumed that TRV would use premium fare airport service.

generation is apparently a complex relationship between resident population characteristics, available airport services and concessions, and access system characteristics, this ratio cannot be considered a casual model for forecasting casual visitor trips. In the absence of an alternative method, however, this ratio was used to forecast the number of casual visitors who would ride each alternative, thus assuming that the rail systems will attract casual visitors in proportion to the number of air passengers attracted.[1/] Since Cleveland's rapid transit network is poorly situated with respect to resident population centers in comparison with Chicago's rapid transit network, the estimates which have been made tend to be conservative. Given the nature of casual visitor trip purposes, it is assumed that for all alternatives casual visitors will use local, non-premium fare CTA trains to O'Hare.

Table V-10 presents the forecasted numbers of casual visitors which would utilize the alternatives under consideration.

IMPACT ON EXISTING COMMUTER RAIL SERVICES

As part of this Study, the Consultant has prepared forecasts of the extent to which Chicago and North Western Northwest line ridership and the Milwaukee Road West line ridership would decline if the CTA were extended from Jefferson Park to O'Hare with intermediate stations at Harlem Avenue and River Road.

[1/] An improvement in this technique would be to use resident air passengers rather than total air passengers, but the absence of air passenger residency data in Chicago has eliminated this possibility.

TABLE V-10

FORECASTED 1983 AVERAGE DAILY CASUAL VISITORS BY ALTERNATIVE[1/]

Alternative	Average Daily Casual Visitors
CTA Extension/Distributor System (Alternative #1)	3,700
CTA Extension/C&NW/Distributor System (Alternative #2)	4,100
CTA Extension (Alternative #4)	3,600
CTA Extension/C&NW Terminal (Alternative #5)	3,300

[1/] It is assumed that casual visitors would use the local, non-premium fare airport service.

The forecasting procedure which has been used involved the development of a mathematical model which forecasts the impact of a CTA extension on the travel habits of individual "ticket-by-mail" riders. A sample of these riders, including their suburban origins and downtown destinations, was supplied by the C&NW and by the Milwaukee Road. Details concerning the forecasting procedure, its assumptions, and the sensitivity analyses conducted are included in Appendix C. It should be noted that some airport-oriented travelers would utilize the C&NW Northwest line to gain access to the rail link between Jefferson Park and O'Hare. Although quantitative estimates of the extent to which this would occur have not been made, it is doubtful that they would significantly offset C&NW passenger diversions to the CTA.

Forecasts were prepared for alternative assumptions regarding policy issues such as:

- CTA Fare -- As a minimum the fare for rapid transit service from Harlem Avenue and River Road stations would be the standard CTA fare of $.45. It is conceivable, however, that an additional increment might be applied similar to those charged for the Congress Service, Evanston Express, or Skokie Swift in view of the trip distance involved.

- Feeder Bus Service -- Currently an extensive feeder bus service serves the Jefferson Park-Kennedy line station. While such service might be provided to Harlem Avenue or River Road stations, it is likely that there might be difficulties encountered in attempting to establish such service in this area, much of which is outside the City of Chicago.

- Station Parking -- The provision and extent of station parking at the Harlem Avenue and River Road could also have a significant impact on commercial rail passenger diversions.

Table V-11 summarizes the diversion forecasts which were prepared to indicate the effects of alternative policy assumptions. All of these forecasts assume a CTA fare of $.55. Appendix Tables C-1 and C-2 present the forecasts which were made in greater detail and indicates the diversion sensitivity to CTA fare level.

TABLE V-11

SUMMARY OF DIVERSION FORECASTS

Forecast Policy Assumptions	C&NW Northwest Line			Milwaukee Road West Line		
	Percent Diversion 2/	Annual Patronage Losses (thousands)	Annual Revenue Losses (thousands)	Percent Diversion 3/	Annual Patronage Losses (thousands)	Annual Revenue Losses (thousands)
1. Feeder Bus Service CTA Station Parking - 370 spaces 1/ CTA Fare = $.55	12	1,200	$800	14	162	$126
2. No Feeder Bus Service CTA Station Parking - 590 spaces 1/ CTA Fare = $.55	9	860	$600	10	116	$ 91
3. No Feeder Bus Service No CTA Station Parking CTA Fare = $.55	6	580	$390	7	77	$ 59

1/ Number of spaces required to accommodate former C&NW and Milwaukee Road riders at Harlem Avenue and River Road stations.

2/ Based on ridership between C&NW station and the Northwest line stations from Jefferson Park through Palatine (11 stations).

3/ Based on ridership between Union Station and West line stations from Elmwood Park through Itasca (7 stations).

Tables V-12 and V-13 present the forecasted diversion by station which would be experienced if CTA station parking was provided but no feeder bus service was available. The C&NW stations which would be most heavily impacted are those from Des Plaines to Norwood Park, while the Milwaukee Road stations most heavily impacted are those from Franklin Park to Bensenville.

TABLE V-12

C&NW DIVERSION BY STATION
- NO FEEDER BUS -
- STATION PARKING AVAILABLE -
- CTA FARE = $.55 -

C&NW Station	Percent Diversion[1]	Annual Ridership Loss[2]
Jefferson Park	7	17,000
Gladstone Park	6	5,000
Norwood Park	39	128,000
Edison Park	21	86,000
Park Ridge	41	373,000
Dee Road	19	59,000
Des Plaines	17	137,000
Cumberland	2	11,000
Mt. Prospect	2	30,000
Arlington Heights	0.4	9,000
Palatine	0.5	5,000
		860,000

1/ Based on number of riders traveling between suburban stations in question and C&NW stations.

2/ Based on 1971 ridership levels.

TABLE V-13

MILWAUKEE ROAD DIVERSION BY STATION
- NO FEEDER BUS -
- STATION PARKING AVAILABLE -
- CTA FARE = $.55 -

Milwaukee Road Station	Percent Diversion[1/]	Annual Ridership Loss[2/]
Elmwood Park	3	8,000
River Grove	3	3,000
Franklin Park	21	52,000
Mannheim	9	2,000
Bensenville	12	25,000
Wood Dale	9	15,000
Itasca	5	11,000
		116,000

[1/] Based on number of riders traveling between suburban stations in question and Union Station.

[2/] Based on 1970 ridership levels.

FORECASTS OF NON-AIRPORT ORIENTED RIDERSHIP

Although the thrust of this study is to develop access systems to serve airport-oriented travelers, each of the systems under consideration would provide local CTA Milwaukee rapid transit service to points between Jefferson Park and O'Hare. Such service would inevitably attract non-airport oriented ridership, primarily commuters traveling between Northwest Chicago and the CBD. The extent of this ridership has significant implications with respect to operating costs and revenue generation.

In the previous section, preliminary diversion forecasts of existing C&NW riders to a local Milwaukee service, operating from stations between O'Hare and Jefferson Park, were presented. These riders, however, would not account for all of the potential non-airport oriented ridership of the local service. Riders would divert from other public transportation services and private autos as well.

In order to estimate total non-airport oriented ridership, the Consultant has utilized 1985 CATS passenger volume forecasts developed for the Crosstown Transit Study, in accordance with the study work program. The only CATS forecasts which have been developed to date are based upon an assumed rapid transit network considerably more extensive than the one tested in this study.[1/] As a consequence, the CATS forecasts were modified to make them compatible with the local rapid transit network under consideration in this study (see Appendix D). The resulting forecast indicates that in 1983, on an average day, 11,000 additional riders would use CTA Kennedy-Milwaukee Service if two intermediate stations were located at Harlem Avenue and River Road. This figure includes travel in both directions.

[1/] Chicago Area Transportation Study, CTPS Network 1, October 1972.

SUMMARY

The patronage of any future rail service to O'Hare will comprise four groups of riders -- air passengers, airport employees, airport visitors, and non-airport travelers. This last group would, in most cases, use one of two possible intermediate stations at River Road and Harlem Avenue. A summary of the projections for the year 1983 indicates the largest group of riders is the air passengers who comprise approximately 35 percent of total patronage. The airport employees and airport visitors contributed approximately 20 percent and 15 percent, respectively. The remaining non-airport travelers will contribute approximately 30 percent of total patronage (see Table V-11).

The precise forecasts of total patronage depend on the alternative tested. The alternative with the greatest patronage is the CTA/C&NW/Distributor System. This alternative provides the most comprehensive service to CBD air passengers and hence attracts more passengers. This difference is reflected in the total patronage of 38,100 for this alternative. The forecasts for the remaining alternatives indicate a range from 34,200 daily passengers for the CTA/C&NW Terminal alternative to 36,200 daily passengers for the CTA/Distributor System. Within these totals the forecasted ridership for airport employees and non-airport oriented travelers is held constant since these riders are assumed to use a local service which is similar for all alternatives.

TABLE V-14

SUMMARY OF SYSTEM PATRONAGE FORECASTS
AVERAGE DAY 1983

User Group	#1 CTA Extension/ Distributor System	#2 CTA/C&NW/ Distributor System	#4 CTA Extension	#5 CTA/C&NW Terminal
Air Passengers[1/]	12,700	14,000	12,300	11,300
Employees[2/]	7,200	7,200	7,200	7,200
Visitors				
Travel-Related	1,600	1,800	1,600	1,400
Casual	3,700	4,100	3,600	3,300
Non-Airport Oriented Travelers	11,000	11,000	11,000	11,000
	36,200	38,100	35,700	34,200

1/ Assumes air passengers use premium fare service at 15 minute headways. Assumed fares for Alternatives 1, 2, 4, and 5 are \$1.70, \$1.80, \$1.60, and \$1.50, respectively.

2/ Assumes employees use local CTA airport service at 9 minute headways with a total fare of 70 cents.

VI. COST AND REVENUE ESTIMATES OF ALTERNATIVE O'HARE-CBD ACCESS SYSTEMS

CONSTRUCTION COST ESTIMATES

The estimates for each alternative system provide order of magnitude construction costs for all major components of each access system under study. These are summarized in Table VI-1. Construction estimate details are found in Appendix E, where breakdowns by construction category are provided for each alternative. All construction figures in this report are given in 1972 dollars. Where necessary, therefore, estimates previously provided (such as that for the CTA Extension) have been employed, and costs escalated, using 7.5 percent per annum.

In Alternative #1, CTA Extension/Distributor System, the components include a rapid transit extension from Jefferson Park to O'Hare Airport plus a partial allowance for the tunnel connection between the Milwaukee Service and the Distributor System.

For Alternative #2, CTA/C&NW/Distributor System, two possible approaches are indicated. Referring to Table VI-1, the estimate for the first approach assumes the need for construction of a separate and independent track system on the C&NW right-of-way for exclusive use by the premium service airport trains. The second construction approach for this alternative assumes that the existing three-track C&NW system would be used by both C&NW commuter trains as well as the airport premium fare system. This estimate includes provision for substantial upgrading of a high-capacity CTC-type, bi-directional signal and control system on the existing tracks to permit dual vehicle operation. The connections indicated include an incline at Jefferson Park, to join the C&NW and CTA tracks, and a bridge-tunnel near Grand Avenue which would permit airport service rapid transit trains to enter the Distributor System.

TABLE VI-1

CONSTRUCTION COST COMPARISON
O'HARE ACCESS ALTERNATIVES

Alternative	Major Construction Components	Estimate	Total
#1 - CTA Extension/ Distributor System	• CTA Extension, Jefferson Park-O'Hare	$79,925,000	
	• Distributor Tunnel Allowance	8,870,000	$ 88,795,000
#2 - CTA/C&NW/ Distributor System	• CTA Extension, Jefferson Park-O'Hare	$79,925,000	
	• Connections plus separate track system on C&NW ROW	47,106,000	$127,031,000
	• CTA Extension, Jefferson Park-O'Hare	$79,925,000	
	• Connections plus upgrading existing C&NW track, signals, and controls	25,970,000	$105,895,000
#4 - CTA Extension	• CTA Extension, Jefferson Park-O'Hare		$ 79,925,000
#5 - CTA/C&NW Terminal	• CTA Extension, Jefferson Park-O'Hare	$79,925,000	
	• Connection plus separate track system on C&NW ROW	32,168,000	$112,093,000
	• CTA Extension, Jefferson Park-O'Hare	$79,925,000	
	• Connection plus upgrading existing C&NW track, signals, and controls	10,630,000	$ 90,555,000

In Alternative #4, CTA Extension, the estimate is based on costs provided by City of Chicago DPW, Bureau of Engineering, and escalated to 1972 costs.

As in the prior C&NW system described, Alternative #5, CTA/C&NW Terminal, portrays estimates for both new track and new signaling approaches. The C&NW-CTA connection at Jefferson Park is also included.

All total construction estimates for each alternative include an estimate for the CTA Extension.

VEHICLE FLEET COSTS

Table VI-2 provides comparison cost estimate data on car fleet cost for each estimate. Every alternative would require one of the fleets indicated for its premium fare service, plus the local service fleet shown.

Premium fare service car estimates include costs for minor modifications (as for seats and baggage racks in the case of Alternatives 1 and 4) and provide an allowance for the hybrid vehicle power source for Alternatives 2 and 5.

ANNUAL REVENUES/OPERATING COSTS

Annual revenues have been estimated on the basis of air passenger, employee, visitor, and non-airport oriented traveler projections made in Chapter V, and a fare structure as described in the same chapter and summarized in Table VI-4 . Revenues are shown in Table VI-3 for each alternative from both local and premium fare riders.

TABLE VI-2

VEHICLE FLEET COST ESTIMATES

Alternative	Number of Cars	Unit Estimate	Total Fleet Cost
	Premium Service Cars		
#1 - CTA Extension/ Distributor System	54	$250,000	$13,500,000
#2 - CTA/C&NW/ Distributor	58	360,000	20,900,000
#4 - CTA Extension	54	250,000	13,500,000
#5 - CTA/C&NW Terminal	46	360,000	16,500,000
	Local Service Cars		
All Alternatives	66	$240,000	$15,840,000

TABLE VI-3

ANNUAL REVENUES/OPERATING COST COMPARISON
O'HARE ACCESS ALTERNATIVES

Alternative	Annual Revenues	Annual Operating Costs	Annual Operating Surplus or (Deficit)
#1 - CTA Extension/Distributor System			
Local Service	$ 5,000,000	$ 5,600,000	($ 600,000)
Premium Fare Service	8,890,000	8,240,000	650,000
	$13,890,000	$13,840,000	$ 50,000
#2 - CTA/C&NW/Distributor System			
Local Service	$ 5,000,000	$ 5,600,000	($ 600,000)
Premium Fare Service	10,370,000	10,890,000	(520,000)
	$15,370,000	$16,490,000	($1,120,000)
#4 - CTA Extension			
Local Service	$ 5,000,000	$ 5,600,000	($ 600,000)
Premium Fare Service	8,120,000	7,360,000	760,000
	$13,120,000	$12,960,000	$ 160,000
#5 - CTA/C&NW Terminal			
Local Service	$ 5,000,000	$ 5,600,000	($ 600,000)
Premium Fare Service	6,940,000	11,010,000	(4,070,000)
	$11,940,000	$16,610,000	($4,670,000)

Also given in Table VI-3 are annual operating costs for each alternative and for both services with the various alternatives. Net operating surpluses or deficits are indicated.

At best, such estimates should be considered helpful only for the relative ranking of alternatives. These figures should not be used for making assumptions about the ability of a system which is to be fully operational some ten years from now, to provide net surpluses. Thus, no attempt has been made to escalate operating costs, especially that of labor, to a 1983 level. Hence, all costs herein indicated are given in 1972 dollars, and are calculated using the latest cost estimates available for operational components.

No inclusion has been made in these figures for vehicle depreciation. Allowances have been included in Alternative #5 for C&NW Terminal use charges, and in Alternatives #2 and #5 for a cost allowance representing rental charge for use of C&NW right-of-way to Jefferson Park.

The assumptions, allowances, and basis for calculations are provided in Appendix F.

TABLE VI-4

ASSUMED FARE STRUCTURE FOR REVENUE CALCULATIONS

Alternative	One-Way Fare
#1 - CTA Extension/Distributor System	
Air Passengers (Premium Fare)	$1.70*
Travel Related Visitors	1.70
Casual Visitors	.70
Local Service (Airport Employees)	.70
Intermediate Station (Jefferson Park-O'Hare) Users	.55
#2 - CTA/C&NW/Distributor System	
Air Passengers (Premium Fare)	$1.80*
Travel Related Visitors	1.80
Casual Visitors	.70
Local Service (Airport Employees)	.70
Intermediate Station (Jefferson Park-O'Hare) Users	.55
#4 - CTA Extension	
Air Passengers (Premium Fare)	$1.60*
Travel Related Visitors	1.60
Casual Visitors	.70
Local Service (Airport Employees)	.70
Intermediate Station (Jefferson Park-O'Hare) Users	.55
#5 - CTA/C&NW Terminal	
Air Passengers (Premium Fare)	$1.50*
Travel Related Visitors	1.50
Casual Visitors	.70
Local Service (Airport Employees)	.70
Intermediate Station (Jefferson Park-O'Hare) Users	.55

*As indicated in Chapter V, the fare levels selected were based on maximizing revenues, according to the sensitivity analysis performed.

QUANTITATIVE EVALUATION OF ESTIMATED SYSTEM COSTS AND BENEFITS

Methods for the quantitative evaluation of alternative projects have been often misused in transportation planning. By the very nature of what they attempt to do, these methods have a number of inherent problems which include:

- Any factors which may be relevant to project evaluation yet cannot be quantified must be excluded.
- Numerous assumptions must be made concerning what should be included in the analysis as project benefit or as project costs.
- There is a tendency to mix the benefits which accrue to one group with costs incurred by another group in the analysis.
- The methods require internal assumptions about such things as project life, interest rates, and salvage value, all of which are frequently difficult to ascertain yet influence the analysis results.

These problems are serious limitations and clearly point to the conclusion that a quantitative evaluation method by itself should not constitute project evaluation or a decision-making mechanism. Nevertheless, quantitative evaluation methods can produce useful input to the decision-making process when used in conjunction with other quantitative and qualitative inputs. Provided their results are scrutinized with respect to their underlying assumptions, these methods can give both relative and absolute insights concerning the value of particular projects. It is in this context that such methods were used in this study.

To compare the systems under consideration, the present worth of project benefits and project costs were calculated for each alternative. From these results the net present worth and benefit-cost ratio were then computed for each alternative. The analysis assumptions included the following:

- Benefits were defined as savings in travel time or travel costs which would accrue to the airport-oriented system users. Potential benefits to non-airport oriented system users were not included.
- A project life of 40 years was assumed commencing in 1976.
- 1972 construction and operating costs and fare levels were used without escalation for the 1976-2016 period. This, in effect, assumes that costs and fare levels will rise proportionately.
- A discount rate of 6 percent was assumed.
- The value of travel time for air passengers and travel-related visitors depended on mode but averaged $5 per hour, and the value of employees' and casual visitors' travel time was assumed to be $2.50 per hour.
- Benefits were taken as constant after 1983, thus assuming that once the 30 million annual enplanement level is reached, no further growth in access travel will take place.
- Benefits were estimated at the 1969 air passenger enplanement level and at the 30 million enplanement level for 1983, and assumed to increase linearly between 1969 and 1983.
- Construction costs are used including the costs associated with constructing intermediate stations between Jefferson Park and O'Hare.

Tables VI-5 and VI-6 summarize the results of the analysis. Table VI-5 presents the estimated access cost savings for 1969 and 1983 for each alternative. The net present worth of benefits and the benefit-cost ratio are presented in Table VI-6. These figures indicate that Alternative #4, the CTA extension, would have the greatest net benefits and the highest benefit-cost ratio given the analysis assumptions.

Alternative #4 would realize over 85 percent of the user benefits of the most favorable alternative in this respect -- Alternative #2, the CTA/C&NW/Distributor System. Yet, Alternative #4 would have the lowest construction and fleet cost <u>and</u> the lowest annual operating cost of any alternative. These factors combine to give the CTA Extension the most

TABLE VI-5

ANNUAL ACCESS COST SAVINGS
TO AIRPORT-ORIENTED ACCESS
SYSTEM USERS - MILLIONS OF DOLLARS

	Alternative	Air Passengers		Airport Employees		Travel Related Visitors		Casual Visitors		Total	
		1969	1983	1969	1983	1969	1983	1969	1983	1969	1983
#1	CTA Extension/ Distributor System	$16.4	27.9	0.3	0.6	4.3	7.3	.03	.06	21.03	35.86
#2	CTA/C&NW/ Distributor System	18.6	31.7	0.3	0.6	4.5	7.7	.04	.08	23.44	40.08
#4	CTA Extension	15.9	27.4	0.3	0.6	3.9	6.6	.03	.06	20.13	34.66
#5	CTA/C&NW Terminal	13.5	23.1	0.3	0.6	3.6	6.1	.03	.06	17.43	29.86

TABLE VI-6

PRESENT WORTH OF BENEFITS AND COSTS
MILLIONS OF DOLLARS

	Alternative	Benefits	Construction and Fleet Costs	Operating Cost	Net Present Worth	Benefit-Cost-Ratio
#1	CTA Extension/ Distributor System	449	103.5	207	138.5	1.45
#2	CTA/C&NW Distributor System	503	149.1 1/ (128.0) 2/	248	105.9 1/ (127.0) 2/	1.27 1/ (1.34) 2/
#4	CTA Extension	436	94.6	195	146.4	1.51
#5	CTA/C&NW Terminal	375	129.8 1/ (108.3) 2/	250	-4.8 1/ 16.7 2/	.96 1/ 1.05 2/

)

1/ Assuming separate track system on C&NW right-of-way.

2/ Assuming use of existing track on C&NW right-of-way with upgraded signal system.

favorable benefit-cost ratio and total net benefits of the four alternatives. Alternative #2, the second most favorable alternative, would produce 6 percent less total benefits than Alternative #4 and would have a 4 percent lower benefit-cost ratio.

VII. SUMMARY AND RECOMMENDATIONS

SUMMARY OF EVALUATION FACTORS

Quantitative Evaluation Factors

Chapters IV, V, and VI have presented forecasts indicating the extent to which each of the alternative systems effectively satisfy the evaluation criteria and factors identified in Chapter III. The quantitative forecasts which were developed lend themselves to tabular summary. Table VII-1 summarizes the forecasts of patronage, revenues, and costs for each system under consideration. These figures are shown as indices in Table VII-2 so that the relative standing of each alternative may be more clearly indicated. The indices were computed by dividing each forecasted parameter value from Table VII-1 by the minimum value that parameter assumes in its particular category. Thus, the construction index of 1.40 for Alternative 5, for example, indicates that Alternative 5 has 40 percent higher construction costs than Alternative 4, the alternative for which the construction index equals 1.

Similarities of Qualitative Characteristics

It is felt that the four alternatives access systems evaluated do not differ significantly in several respects.

For example, the level of service offered to airport employees using local trains is essentially equivalent for all alternatives. This is also true for non-airport related riders who would use stations between Jefferson Park and O'Hare.

TABLE VII-1

SUMMARY OF PATRONAGE, REVENUE, AND COST ESTIMATES

	#1 CTA Extension/ Distributor System	#2 CTA/C&NW/ Distributor System	#4 CTA Extension	#5 CTA/C&NW Terminal
Total Annual Patronage	13,200,000	13,900,000	13,000,000	12,500,000
Annual Revenues	$13,890,000	$15,370,000	$13,120,000	$11,940,000
Annual Operating Costs	$13,840,000	$16,490,000	$12,960,000	$16,610,000
Construction Costs	$88,795,000	$127,031,000 ($105,895,000)1/	$79,925,000	$112,093,000 ($90,555,000)1/
Premium Fare Vehicle Costs	$13,500,000	$20,900,000	$13,500,000	$16,500,000
Local Service Vehicle Costs	$15,840,000	$15,840,000	$15,840,000	$15,840,000

1/ Construction cost if new trackage in C&NW right-of-way not required.

TABLE VII-2

PATRONAGE, REVENUE, AND COST INDICES[1/]
OF ALTERNATIVE SYSTEMS

	#1 CTA Extension/ Distributor System	#2 CTA/C&NW/ Distributor System	#4 CTA Extension	#5 CTA/C&NW Terminal
Total Patronage	1.06	1.11	1.04	1.00
Revenues	1.16	1.29	1.10	1.00
Operating Costs	1.07	1.27	1.00	1.29
Construction Costs	1.11	1.59 (1.33)[2/]	1.00	1.40 (1.13)[2/]
Total Vehicle Costs	1.00	1.25	1.00	1.10

[1/] Index indicates relative magnitudes of alternative system characteristics based on lowest value within each category.

[2/] Index if new trackage in C&NW right-of-way not required.

Vehicle comfort for both premium and local services, and baggage accommodations would also be entirely similar between alternatives. Additionally, all alternatives provide similar characteristics of enroute passenger loadings, i.e., air passenger trains make minimal stops enroute. Thus they prevent the potential for extreme intermediate loadings, a source for possible future service rejection by premium fare riders.

All four alternatives provide use intensification of existing transportation facilities and right-of-way. Ranking on this basis would primarily be a function, therefore, of selecting the particular right-of-way and/or facility whose increased use would provide superior benefits.

Dissimilar Qualitative Characteristics

The following listing by alternative indicates those significant characteristics which are not common to all systems evaluated.

Alternative #1 -- CTA Extension/Distributor System

Features

- Good CBD distribution
- Good regional access
- Good potential for satellite terminal

Disadvantages

- Potentially long peak load dwells on main line due to airport train loading
- Regularity of service may suffer; trains run between service local

Alternative #2 -- CTA/C&NW/Distributor System

Features

- Good CBD distribution
- Superior regularity of service
- Good regional access
- Minimizes overall trip time

Disadvantages

- New technology introduction (turbines) may present maintenance problems
- Requires some demolition and ROW acquisition
- Construction on C&NW ROW may disrupt existing rail commuter service
- Would require permanent road closings
- Would increase C&NW ROW noise quantity
- Potential labor problem for CTA operation on railroad right-of-way

Alternative #4 -- CTA Extension

Features

- No land acquisition needed
- Adequate CBD distribution
- Regionally accessible

Disadvantages

- Potentially long dwells peak load on main line due to airport train loading
- Poor potential for satellite terminal
- Regularity of service may suffer; all trains follow on same track
- Trip time not minimized

Alternative #5 -- CTA/C&NW Terminal

Features

- Peak load dwells not significant problem
- Superior regularity of service
- Line haul times short

Disadvantages

- Very poor CBD distribution
- Regional access difficult
- Lengthy access time to terminal from CBD sections
- Requires some ROW acquisition
- Construction on ROW may disrupt existing commuter service
- Noise quantity on C&NW increases
- New technology introduction (turbines) may present maintenance problems
- Potential labor problem for CTA operation on railroad right-of-way

RECOMMENDED PROGRAM

As indicated in the Work Program for this Study, development of a Long-Range Airport Access Plan is to be a joint effort by the Consultant, the City, and the Technical Advisory Committee. The program recommendation made in this report is that of the Consultant with respect to the CBD-O'Hare access facility. In Phase III of this Study, the Long-Range Airport Access Plan will be screened and components of it described in greater detail. Parts of the plan to be detailed in Phase III include specific operational concepts and feeder-collector services for the CBD-O'Hare access system.

Basic Plan Recommended

The basic plan recommended for CBD-O'Hare access is that represented by Alternative #4, CTA Extension. Four basic rationale elements guided the Consultant in this recommendation. These are as follows:

a. The alternative recommended should provide an adequate level of service -- especially with respect to regional distribution and accessibility -- and therefore should have the potential of attracting a relatively large number of air passengers and airport employees.

b. The alternative recommended should have the strongest tendency to provide the most favorable operating ratio.

c. The alternative recommended should retain all, or most, options open with respect to future improvements of service by the addition of new facilities and/or the construction of improved system routing and distribution capabilities; but at the same time, it should minimize the need for construction of improvements and facilities, if any, which would only temporarily be used.

d. The alternative recommended should be capable of meeting the other criteria at a reasonable first cost.

It is the Consultant's opinion that Alternative #4, CTA Extension, provides the best and most suitable compromise in satisfying these criteria. In particular:

a. The recommended alternative would serve 94 percent of the users attracted to the highest rated alternative, in terms of overall annual patronage, and offers highly acceptable regional distribution.

b. The recommended alternative is clearly the one most fiscally responsible, in terms of its operating cost/operating revenue future.

c. The recommended alternative retains open all future construction/improvement options, while at the same time (1) providing in and of itself highly adequate airport access services to both major user groups, and (2) requiring no temporary facilities of substantial cost.

d. The recommended alternative has the lowest first cost of all alternatives, while having the highest benefit-cost ratio.

Further Development

The proposed Distributor subway, should it be developed in such a way that it could accept the vehicle system and operations of the Airport Service, would offer the potential for significant improvement of Airport Service.

It should be noted, however, that Airport Service needs by no means warrant the building of the Distributor solely on their account; nor should Airport needs necessarily have predominant influence in Distributor design or selection of an operational concept for it.

The future existence of a compatible Distributor would offer the opportunity for a later stage development of Airport Service at that time. The system, in that event, would have the characteristics of Alternative #1, CTA Extension/Distributor System. The principal benefit of further

development would be the opportunity for establishment of an off-line station near Prudential Center, where airline ticketing and baggage checking facilities might be provided, along with effective taxi and bus interface. In addition, through Airport Service to McCormick Place and Hancock Center could be provided.

APPENDICES

APPENDIX A

SELECTION AND APPLICATION OF AIR PASSENGER MODE CHOICE MODEL

INTRODUCTION

Airport access modal split models are used to predict the ground access/egress mode choice of air passengers by relating the choice of air passengers to the service characteristics of alternative access models. In selecting a modal choice model, three specifications were established for such a model:

- The model must be multimodal since this is the choice confronting the air passenger using O'Hare International Airport.
- The model should be causal and based on economic theory.
- The model should be capable of forecasting the modal share of a new access mode.

This appendix discusses three alternative models and their ability to meet these specifications. The details of application for the selected model are then discussed.

MODEL SELECTION

Modified Baumol-Quandt Model

The first model investigated was the Baumol-Quandt Model. This model was originally formulated as a demand model which estimated the number of trips by a particular mode between a zonal pair. In a simplified form it may be stated as

$$T_m = \beta_m \prod_i O_i^{\beta_i} D_i^{\gamma_i} x_{im}^{\delta_i} \left\{\frac{x_{im}}{x_{ib}}\right\}^{\alpha_i} \qquad (A.1)$$

in which T_m = the number of trips between any zonal pair by mode m

O_i = a socio-economic characteristic i of the origin zone; O_i is typically the population and income of a zone

D_i = a socio-economic characteristic i of the destination zone

x_{ib} = a transportation system variable i for the "best" mode, b, between the selected zonal pair.

x_{im} = a transportation variable i for any mode m which may or may not be the "best" mode; x_{im} is typically the travel time or travel cost by mode m between the selected zones

β_m = a calibration constant for the mode m

$\alpha_i, \beta_i, \gamma_i, \delta_i$ = calibration constants for attribute i.

The "best" mode is defined as that mode for which the attribute has the lowest disutility. For example, the "best" mode in terms of travel time between the selected zones is the mode which is fastest. Alternatively, the "best" mode in terms of travel cost is that mode which has the lowest out-of-pocket cost. It is not necessary that these modes be the same for a particular zonal pair. In other words, the mode with the lowest out-of-pocket cost is not necessarily the fastest mode. Using this demand model it is possible to transform the model to estimate the mode split, w_m, between zones as follows:

$$w_m = \frac{T_m}{\sum_j T_j} \qquad (A.2)$$

where w_m = the mode share of mode m between the selected zones

T_j = the number of trips between zones by mode j

Hence, the mode split form of the Baumol-Quandt Model is as follows:

$$w_m = \frac{\beta_m \prod_i x_{im}^{\alpha_i}}{\sum_j \beta_j \prod_i x_{ij}^{\alpha_i}} \tag{A.3}$$

where w_m = the mode share of mode m between the selected zones

x_{im} = a transportation system variable i for mode m between the selected zonal pair

α_i = calibration constant for attribute i

x_{ij} = a transportation system variable i for mode j which may or may not be the "best" mode

β_j = calibration constant for mode j

It can be shown that this equation is the solution of an econometric model relating the elasticity of a mode to the modal split.[1/] This model is as follows:

$$e_{ij}^{m} = \alpha_i (\delta - w_j) \qquad \begin{matrix} \delta = 0 & m \neq j \\ \delta = 1 & m = j \end{matrix} \tag{A.4}$$

[1/] Elasticity of a given mode m, to attribute i, in mode j is defined as the percentage change in the given mode due to a 1% change in the attribute of the given mode or an attribute of a competing mode.

$$e_{ij}^{m} = \frac{x_{ij}}{w_m} \frac{\partial w_m}{\partial x_{ij}}$$

in which e_{ij}^{m} = the elasticity of mode m to attribute i of mode j

α_i = the coefficient of attribute i

w_j = the modal share of mode j.

The above expression says that if an attribute of mode j is altered by 1 percent, then the percentage change in mode, m, depends on the mode share whose attribute is changed. If it is large, then the change in mode m will be large. However, if an attribute of mode m is changed and the same conditions apply, then the change in mode, m, will be small. This all appears intuitively correct, and adequately meets the specification outlined in the introduction. For example, the model can handle any number of modes, it is also based on the economic theory of consumer behavior, and it does not require the estimation of any mode specific constraints for a "new" mode. The ability to meet this third specification occurs because the model assumes that the riders of all modes perceive longer travel times and/or increased costs in the same manner, irrespective of mode. This is perhaps a doubtful assumption. The model also neglects any influence on the absolute levels of fares or travel times. Instead, it assumes that a 1 percent change in a fare will produce the same change in mode share when the fare is $2.00. Again this is a doubtful assumption. For these reasons then this modified Baumol-Quandt Model was rejected.

McLynn-Watkins Model

The second model investigated was the McLynn-Watkins Model. This model, like the modified Baumol-Quandt Model, states "the elasticity of the share of a given mode with respect to an attribute of any mode is proportional only to the modal share of this other mode." Or alternatively

$$e_{ij}^{m} = \alpha_{ij} (\delta - w_j) \qquad \begin{array}{ll} \delta = 0 & j \neq m \\ \delta = 1 & j = m \end{array} \qquad (A.5)$$

in which e_{ij}^{m} = the elasticity of mode m with respect to attribute i of mode j

α_{ij} = the mode specific constant for attribute i of mode j

w_j = the modal share of mode j.

The solution which follows from this assumption is as follows:[1/]

$$w_m = \frac{\beta_m \Pi x_{im}^{\alpha_{im}}}{\sum_j \beta_j \Pi x_{ij}^{\alpha_{ij}}} \qquad (A.6)$$

in which: x_{ij} = an attribute, i, of mode j; for example, travel time or travel cost

α_{ij} = a mode specific constant for attribute i

β_m = a constant for mode m.

The simalirity of this solution with the modified Baumol-Quandt Model is worthy of note (Equation A.3).

The main difference between this model and the modified Baumol-Quandt Model is that the McLynn-Watkins Model recognizes that the riders of different modes may have differing perceptions of the travel times and travel costs. This is shown in the calibration constant α_{ij} which is mode specific. Apart from this, the models are identical.

1/ Analysis and calibration of a modal allocation model (revised), June 1967. North East Corridor Project.

This model, like the previous model, adequately meets the first two specification requirements. However, its ability to meet the third requirement, viz. the prediction of the influence of a "new" mode, depends on selection of the mode specific constant α_{ij} for the new mode. A dilemma, which is common in mathematical modelling, therefore arises. Increasing the generality of the model has restricted the predictive ability of the model. However, by examining the constants for other modes, a reliable trend may be observed. Hence, the estimate of the parameters for the new mode may be still better than assuming the same constant for all modes.

Multinomial Logit Model

This third model was originally calibrated for the Washington-Baltimore airport access study.[1/] However, its solution has been known for some time.[2/] Mathematically, the model is expressed as follows:

$$\frac{\partial w_m}{\partial x_{ij}} = \alpha_{ij} \, w_m \, (\delta - w_j) \qquad \begin{matrix} \delta = 0 & m \neq j \\ \delta = 1 & m = j \end{matrix} \tag{A.7}$$

where w_m = the modal share of mode m

x_{ij} = the attribute, i, of mode j; for example, travel time or cost

α_{ij} = the constant of proportionality for attribute i of mode j

If expressed in the more familiar terms of elasticity, the model says:

> "The elasticity of the share of a given mode with respect to the attribute of any mode is jointly proportional to the modal share of this other mode and to the level the attribute in this other mode." Or alternatively,

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1/ N-Dimensional Logit-Model: Development and Application; Peat, Marwick & Co., Washington, D.C., 1970.

2/ Theil, H. Applied Economic Forecasting, Amsterdam, North Holland Publishing Co., 1966.

$$e_{ij}^{m} = \alpha_{ij} \, x_{ij} \, (\delta - w_j) \qquad \begin{matrix} \delta = 0 & m \neq j \\ \delta = 1 & m = j \end{matrix} \tag{A.8}$$

where symbols are defined above.

The solution of this model is slightly different from the previous two models.

$$w_m = \frac{\exp(\alpha_{im} \, x_{im} + \beta_m)}{\sum_j \exp(\alpha_{ij} \, x_{ij} + \beta_j)} \tag{A.9}$$

where w_m = the mode share of mode m

x_{ij} = an attribute, i, of mode j; for example, the travel time or travel cost

α_{ij} = a mode specific constant for attribute i

β_j = a mode specific calibration constant for mode j

The most significant difference between this model and the previous two is that it incorporates the absolute level of the attribute where influence is being evaluated. For example, the change in the mode share of a given mode, m, resulting from a 1 percent change in the fare of that mode or any other mode, does depend on whether the initial fare is 20 cents or $2.00. Intuitively, this appears reasonable.

This model has all the advantages and disadvantages of the previous two models, plus incorporating the absolute level of the various attributes. For these reasons then this model appears the most theoretically desirable. In an earlier chapter it was stated that the available data would not support the calibration of a mode choice model for any of the forms described. Thus, a previously calibrated model would have to be used. The multinomial logit model of the Washington-Baltimore Airport Access Study was the

only model currently available.[1/] The previous discussion had demonstrated its theoretical validity, therefore it was decided that this calibrated model would be applicable in Chicago and should produce reliable estimates.

DESCRIPTION OF MULTINOMIAL LOGIT MODEL

This section describes in greater detail the calibration procedures followed in the original calibration for the Washington-Baltimore Study. This enables a critical evaluation of the model's reliability. An interpretation of the meaning of the calibration coefficients is also given, and a discussion of the model's use in the predictive phase is made.

The modes considered in the original calibration were the same as those currently providing access to O'Hare International Airport:

- Private Cars
- Taxi
- Rental Car
- Limousine or Coach Service.

The attributes of the modes used to describe the modal share were:

- Door-to-door travel time
- Out-of-pocket expenses.

The users were also stratified by trip purpose and direction of travel. This resulted in four different models being calibrated:

- Business trips to the airport
- Business trips from the airport
- Non-business trips to the airport
- Non-business trips from the airport.

[1/] N-Dimensional Logit Model: Development and Application, Peat, Marwick and Mitchell, Washington, D.C. 1970.

In making this stratification it is recognized that the mode choice decision for persons who are residents of the Chicago area are different than those of non-residents. However, because the residency data was not available for the Washington-Baltimore Access Study or for the Chicago Air Passenger Survey 1969, the weak surrogate of business, non-business is used. The original calibration also recognized that the mode choice decision was influenced by whether an individual was traveling to or from the airport.

In the calibration procedure it was found necessary to convert the door-to-door travel time for each mode to a dollar value. The reason given was that it provided a more plausible calibration result than if door-to-door travel time was input directly. The desirability of this simplification, although practically expedient for producing a statistically feasible calibration result, is theoretically questionable for it removes a significant portion of the variation in travel times by replacing them with a linear relationship with cost. The effect is to change the observed x_{ij}, in this case the travel time by mode, to a new value, which has a linear relationship with the observed travel cost. The extent of this modification can be seen by examining the coefficient of determination, R^2, for the linear regression lines between cost and time. The R^2 values for each of the modes ranged from 0.2 to 0.9, indicating that the linear relationship varied from practically non-existent in the case when R^2 equaled 0.2 to a fair relationship when R^2 equaled 0.9. In no case could it be said that a linear relationship was an accurate description of the relationship between travel time and cost. If it had been, there would be no need for the transformation. We then have the curious situation that the smaller the R^2 value between travel time and cost, the better the statistical tests for the calibrated multinomial model.

The initial calibration attempts tried to isolate the influence of sub-mode travel time and sub-mode costs. Attempts were also made to describe the effect of out-of-vehicle times. However, these attempts all produced unreliable results. This probably occurred because the data used to calibrate the model was aggregate zonal data, i.e., zone-to-zone travel time and cost rather than disaggregate point-to-point data, which would be necessary to isolate these elemental modal choice influences.

This question of aggregation raises an important point regarding the use of the model in the predictive phase. Discussion in recent publications has indicated that there are considerable benefits to be gained in the development of individual stochastic mode choice models.[1/] However, when such models come to be used in the predictive phase, difficulties arise because disaggregate individual data must be available for this future design year. Or, alternatively, the distribution of individuals within the future aggregated areas must be known in respect to any attribute used in the calibration process. Such a requirement is often difficult to achieve.

More concisely, we are saying that the mean probability of an individual choosing mode m between i and j, given his travel time between i and j, does not equal the probability of an individual choosing mode m between i and j given his mean travel time between i and j. (Equation A.10.)

$$\overline{P}\,(m_{ij}/X_{ij}) \neq P\,(m_{ij}/\overline{X}_{ij}) \qquad \text{(A.10)}$$

where $\overline{P}\,(m_{ij}/X_{ij})$ = the mean probability of using mode m between i and j given a travel time X_{ij} between i and j

$P\,(m_{ij}/\overline{X}_{ij})$ = the probability of using mode m between i and j given the mean travel time $\overline{X}_{ij}$ between i and j

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1/ S. Richman, P.R. Stopher, "Disaggregate Stochastic Models of Travel Mode Choice," HRB Record 369, 1971.

This inequality can be removed if the distribution of X_{ij} is known

$$\overline{P}(m_{ij}/X_{ij}) = \sum_{-\infty}^{x_{ij} = X_{ij}} P(m_{ij}/x_{ij}) \cdot P(x_{ij}) \qquad (A.11)$$

where symbols as above and $P(x_{ij})$ is the probability of travel time x_{ij} between i and j.

In applying the multinomial logit model calibrated for the Washington-Baltimore Access Study to the Chicago Access Study, this problem is not critical. The model was applied at two levels. Firstly, at a fine level for 15 quarter-mile zones within the CBD. Here the distribution of x_{ij} is narrow; for example, the travel time by mode, m, to O'Hare varies little within any one zone, hence the equality will hold. Secondly, for non-CBD areas the model will be applied at zonal sizes comparable to the Washington-Baltimore Study.

The initial calibration attempts used least squares regression techniques. However, this produced unreliable results so a maximum likelihood method was attempted. This produced more satisfactory results for the calibration coefficients. These coefficients for each of the four groups of users is shown in Table A-1.

A discussion of the values of these coefficients has been extracted from the original calibration report.[1/]

[1/] The N-Dimensional Logit Model: Development of Application, Peat, Marwick, Mitchell & Co., 1970.

TABLE A-1

CALIBRATED TIME AND COST COEFFICIENTS

	Private Car		Rented Car		Taxi		Limousine	
	Time (min)	Cost ($)	Time (min)	Cost ($)	Time (min)	Cost ($)	Time (min)	Cost ($)
Business Trips To Airports	-.0401	-1.9097	-.0265	-.6030	-.0624	-.3962	-.0224	-1.0646
Business Trips From Airports	-.0276	-1.3031	-.0150	-.3505	-.0642	-.3447	-.0106	- .5482
Non-Business Trips To Airports	-.0342	-1.6058	-	-	-.0631	-.4025	-.0177	- .7922
Non-Business Trips From Airports	-.0144	- .6767	-	-	-.0573	.3082	-.0104	- .5348

Source: Peat, Marwick, Mitchell & Co., "The N-Dimensional Logit Model: Development and Application," 1970.

- For each mode and each trip purpose stratification, travelers seem to be more sensitive and, hence, more likely to change modes when going to rather than when leaving the airport. As the calibration sample does not distinguish between residents and non-residents, this cannot be explained by familiarity with the region. Among other factors, it is due to the importance attached by the traveler to "making his flight."

- The high sensitivity of the private car to cost is an indicator which shows that cost, as expected, can be a powerful deterrent from using a car, especially for long duration trips. Most probably this would have appeared were this mode broken into three classes: those travelers who are driven to the airport, those who park for a short duration (3 days or less), and those who park for a long duration. Parking cost was taken as an average measure based on the average proportion of travelers who park their vehicle at the airports and their average duration of parking.

- Between the two purpose stratifications, it is surprising to note that the private car cost coefficients and, therefore, the sensitivities to this measure, are higher in the case of business trips, regardless of the trip direction. This unexpected result could be attributed to the fact that non-business travelers are often accompanied to or met at the airport. This reason also suggests that the higher cost coefficients of the business trips reflect the cost of the "unavailability" to the rest of the household of a personal vehicle parked at an airport.

- Rented car sensitivity to time is low and, in fact, ranks third following taxi and private car. This probably suggests that the business man renting a car does not use it solely for airport access reasons. In most cases, a taxi ride would be more convenient and faster, in particular when downtown parking is required. It can be conjectured that an automobile has the advantage of "flexibility" when several trips are projected in the area visited.

- Taxi displays, somewhat markedly, and regardless of the trip purpose, the highest sensitivity to time. Two related justifications to this could be found. National Airport "points" dominated the calibration sample, and taxi fares thereto and therefrom are relatively low, which makes this mode particularly attractive.

TABLE A-2

EMPIRICAL CONSTANTS FOR MODE SPLIT MODEL[1/]

Mode	Central Business District	Area Beyond Central Business District But Within City Limits
Private Car	0.00	0.90
Rental Car	0.50	0.90
Taxi	1.55	0.00
Limousine/Coach	-0.50	-1.40

[1/] These constants apply to business trips to the airport.

- The relatively low sensitivity to taxi cost can be explained by the latter justification presented above, i.e., the relatively low fare of taxi. Most probably, were this fare significantly higher and, hence, not within the means of most travelers, the sensitivity might be higher.
- As expected, limousine displays the least sensitivity to time and second highest sensitivity to cost after private car. This is due, in all likelihood, to the competition offered by taxi which is faster and, in absolute terms, not much more expensive (especially in group riding) to areas close to an airport. Hence, were limousine cost to increase, ceteris paribus, in any significant amount, one would expect the attraction of taxi to be "irresistible."

Finally, the mode specific constant β_j referred to in Equation (A.9) were fitted empirically so that the estimated modal share in each of the four major analyses matched the observed share (Table A-2). The model was only fitted for two areas, i.e., the CBD and the area immediately beyond the CBD but within the City limits. It was only these areas which would be significantly impacted by a rapid rail service.

The model was applied to business trips to the airport. The other three possible stratifications were omitted because firstly no data was available for trips from the airport in the calibration year; and secondly the number of non-business trips from the CBD was only 7.4 percent in 1969 and 15.9 percent from the non-CBD area. With these four observations it was felt that any fitting of the empirical constants would be unreliable.

APPENDIX B

AIRPORT EMPLOYEE AIRPORT ACCESS MODE CHOICE MODEL

As noted in Chapter V, access mode choice for airport employees was forecasted using a mathematical model supplied by the Chicago Area Transportation Study.[1/] The particular model used is an auto-rail transit, binary choice, logit model calibrated with 1956 zonal work trip data. The mathematical form of the model is as follows:

$$\text{Mode Share by Auto}^{2/} = \frac{e^{G(x)}}{1 + e^{G(x)}}$$

where

$$G(x) = 1.1 - .0111\,(\Delta C) - .0376\,(\Delta T) + .0111\,(d)$$

in which ΔC = Auto cost per trip[3/] minus transit cost per trip (min)

ΔT = Auto travel time minus transit travel time (min)

d = distance of trip in miles

In addition to this model, several other models were tested, including other models provided by (CATS) and other logit models calibrated with individual data collected in the Chicago region.[4/] Given the differences in the particular situations modelled, all of the models were in general agreement.

1/ Wigner, Martha, unpublished C.A.T.S. research.

2/ For an individual, this would be a probability of choosing auto for access.

3/ Includes marginal costs per trip plus an apportioned share of automobile capital costs.

4/ Stopher, Peter R., and Lavender, John O., "Disaggregate, Behavioral Travel Demand Models: Empirical Tests of Three Hypotheses," paper to be presented to the Annual Meeting of the Transportation Research Forum, November 1972.

APPENDIX C

IMPACT ON EXISTING COMMUTER RAIL PASSENGER SERVICES: FORECAST PROCEDURE

This appendix presents the method of analysis which was employed to forecast the passenger diversions from Chicago and North Western (C&NW) Northwest line and the Milwaukee Road West Line to a proposed extension of the CTA Kennedy line.

The analysis method can be summarized as follows: A sample of C&NW Northwest line riders and Milwaukee Road West line riders was selected; and for each individual of the sample, the probability of diverting to the CTA extension was estimated. These probabilities were then expanded to the total population of riders on the two lines using 1970 and 1971 ridership figures to obtain diversion forecasts.

For convenience, the forecasting procedure will be described with respect to C&NW passenger diversion forecasts only. In general, the same technique was used to forecast Milwaukee Road diversions; however, validation data was available only for the C&NW. The forecasted diversions for both railroad lines are presented at the conclusion of this appendix.

The remainder of this appendix discusses the various components of the analysis which may be broken down as follows:

- Sample Selection
- Estimation of Alternative Travel Times and Travel Costs
- Computation of Disutility Differences
- Transformation of Disutility Differences to Diversion Probabilities
- Validation
- Diversion Forecasts

SAMPLE SELECTION

A random sample of 1972 C&NW Northwest line ticket-by-mail riders was selected using the following sampling rates:

1 out of 2	Irving Park through Gladstone Park
1 out of 3	Norwood Park through Cumberland
1 out of 10	Mt. Prospect through Barrington

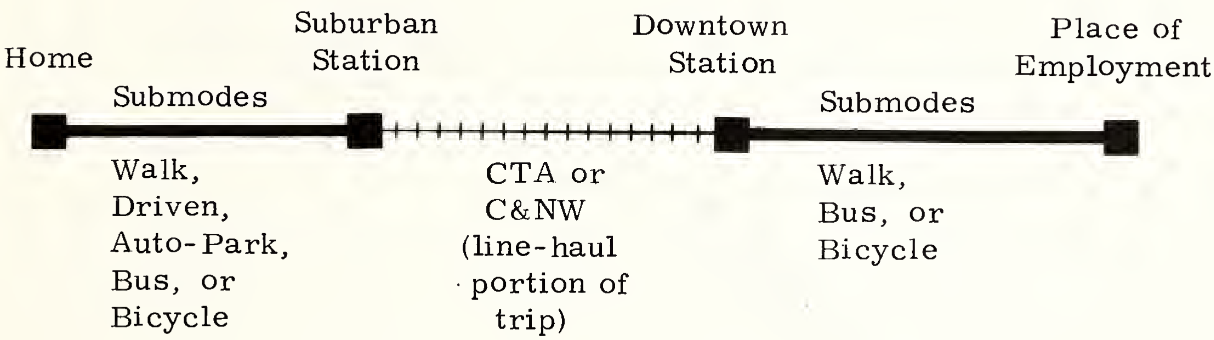
These rates were selected with consideration given to stations previously impacted by the CTA, stations likely to be heavily impacted by a CTA extension, and the number of riders at each station. A total sample of approximately 1200 individuals was produced using these rates. For each individual, the home address and work address was supplied by the C&NW without personal identification. The analysis method assumes that the origin-destination (O-D) patterns of ticket-by-mail passengers are representative of those of all C&NW Northwest line riders. Ticket-by-mail passengers presently constitute approximately 32 percent of the line's ridership.

The West line of the Milwaukee Road has considerably fewer ticket-by-mail riders than the C&NW Northwest line. As a consequence, the sample of Milwaukee Road riders was a 100 percent sample of 1972 ticket-by-mail riders, which amounted to approximately 1000 individuals using the stations from Elmwood Park to Itasca.

ESTIMATION OF ALTERNATIVE TRAVEL TIMES AND TRAVEL COSTS

For each individual in the sample, total trip travel times and travel costs had to be estimated for his/her present work trip using the C&NW and for his/her work trip using a CTA extension instead. Estimates of these travel times and travel costs were based upon existing C&NW suburban and downtown stations, existing Dearborn Street CTA stations, and assumed CTA extension stations. For the purposes of this analysis, two CTA extension stations were assumed, one at Harlem Avenue and one at River Road.

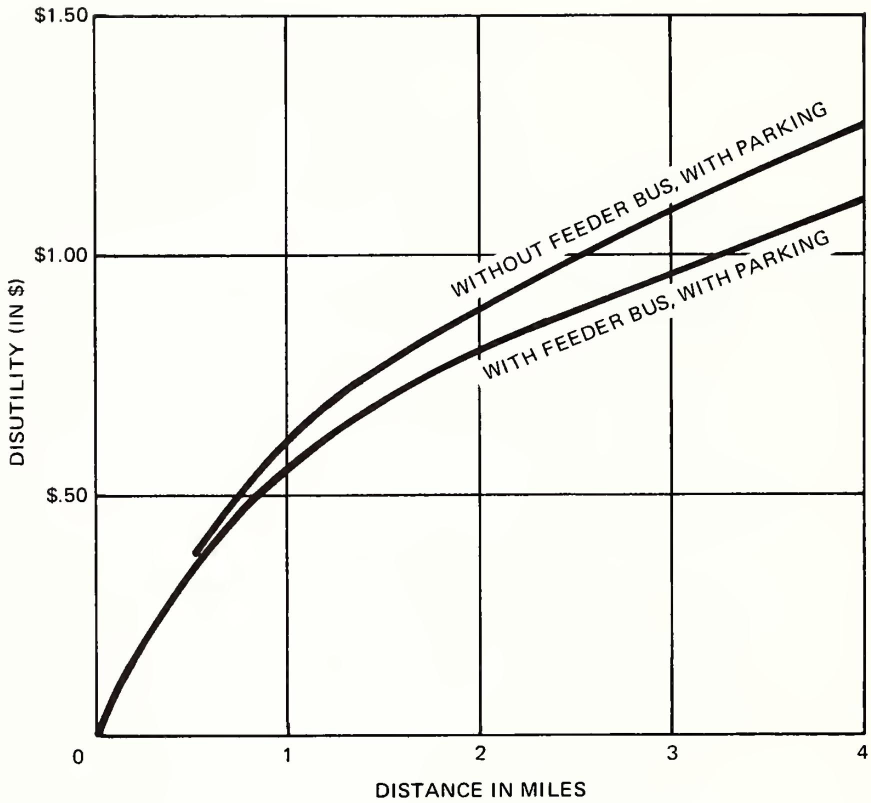
The trip from a Northwest community to the downtown by C&NW or CTA can be broken down into three component parts which are shown by the schematic diagram below.



It was straightforward to estimate the line-haul travel times and costs for each individual by CTA and C&NW. For the CTA, each individual was assigned to the nearest assumed suburban station and to the existing downtown Dearborn Street (CM-DM) subway station nearest his/her place of employment. Using assumed schedule times and a range of fare levels, the CTA line-haul travel times and costs for each individual were estimated. Since the suburban C&NW station presently used by each individual in the sample is known, and since there is only one downtown C&NW station, C&NW line-haul travel times and cost seemingly could be estimated directly from the schedule. This situation is complicated, however, by the multiplying of fare levels and travel times between two stations. The problem was resolved by using a single set of weighted average fares[1/] based on ticket sales and peak hour travel times.

[1/] C&NW fares in effect in May, 1972, were used in this analysis.

Figure C-1
Sample Weighted Disutility-Distance Relationships



To estimate the alternative suburban and downtown station access/egress travel times and costs was a particularly diffficult task. A variety of access/egress submodes are possible, each of which has different associated travel times and costs.

The method selected for handling submode costs and travel times involved the use of disutility-distance relationships. For the purposes of this report, the disutility of a trip or portion of a trip is defined as the total cost in dollars of that trip or portion of a trip, including the value of travel time expended. Using assumed values of travel time and travel costs by submode, disutility-distance relationships were computed as part of the Southward Transit Area Coordination (STAC) Study and Northwest Corridor Modal-Split Project[1/] by submode for commuter rail stations. Using these observed distance-submode split relationships, the mode-specific disutility-distance relationships were transformed into a weighted disutility-distance relationship which is not mode specific. Such curves are shown in Figure C-1. Given a distance from a commuter rail station, it can be used to estimate the disutility in dollars of an access trip to that station.

For suburban C&NW stations, three variations of the STAC study disutility-distance relationship were used. A single relationship could not be used because of differing parking charges and availability at the individual stations. For access costs to potential suburban CTA stations, a disutility-distance relationship provided by the Illinois Department of Transportation[2/] was utilized. This relationship assumes the existence

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[1/] See Southward Transit Area Coordination Study, Final Report, Appendix C.

[2/] Hovind, Mark, "Disutility Curves for O'Hare Ground Access Study," Office of Research and Development, Illinois DOT, September 5, 1972.

of feeder bus routes operating at 10-minute headways and automobile parking for 25 cents a day within a two-minute walk of the station. In order to test alternative assumptions regarding the availability of station access submodes, the relationship was modified to reflect no feeder bus service and no station parking. (See Figure C-1.)

For assessing access costs to the downtown C&NW station and Milwaukee service subway stations, separate disutility-distance relationships were developed using Northwest Chicago Modal-Split Project data and CTA bus route data.

Using the techniques and relationships described in this section, the following quantities were estimated for each individual in the sample:

T_{CTA} = Line haul travel time using CTA extension (in minutes)

$T_{C\&NW}$ = Line haul travel time using C&NW Northwest line (in minutes)

C_{CTA} = CTA fare (in $)

$C_{C\&NW}$ = C&NW fare (or weighted average fare) (in $)

$DU^{S}_{C\&NW}$ = Access/egress disutility to suburban C&NW stations (in $)

$DU^{D}_{C\&NW}$ = Access/egress disutility to downtown C&NW stations (in $)

DU^{S}_{CTA} = Access/egress disutility to suburban CTA stations (in $)

DU^{D}_{CTA} = Access/egress disutility to downtown CTA stations (in $)

COMPUTATION OF DISUTILITY DIFFERENCES

The results of the previous component of the analysis were used to estimate the disutility difference for each individual in the sample. This difference in trip disutility includes both submode and line haul portions of a trip and is the total disutility incurred by an individual who chooses the C&NW for a trip minus the total disutility which would be incurred by the same individual diverting to a CTA extension for the same trip. The following equation was used to compute the disutility difference:

$$\Delta DU = \Delta C + V\Delta T + \Delta DU^{S} + \Delta DU^{D} + (\Delta COM + \Delta F)$$

in which

ΔDU = total trip disutility using C&NW minus total trip disutility using CTA extension (in $)

$\Delta C = C_{C\&NW} - C_{CTA}$

V = Value of line haul travel time ($/min.)

$\Delta T = T_{C\&NW} - T_{CTA}$

$\Delta DU^{S} = DU^{S}_{C\&NW} - DU^{S}_{CTA}$

$\Delta DU^{D} = DU^{D}_{C\&NW} - DU^{D}_{CTA}$

ΔCOM = Value of difference incomfort between the C&NW and CTA on a per trip basis (in $)

ΔF = Value of difference in service frequency between C&NW and CTA on a per trip basis (in $)

All of the variables on the right side of the equation were known at this stage of the analysis except V, the value of line-haul travel time; ΔCOM, the difference in comfort and convenience; and ΔF, the difference in frequency of service. These variables were assumed and sensitivity analyses conducted where necessary.

An analysis of incomes in the Northwest corridor and previous research[1/] indicates that the value of time for commuters in Chicago's Northwest corridor should be in the vicinity of \$2.50 to \$3.00 per hour. This range was used in this analysis.

Of particular concern in the analysis is the method modelling the effects of frequency. Two approaches are possible:

- Include the effects of frequency differences explicitly in the model as ΔF (in \$); or
- Include frequency in the travel time estimates as half the average headway.

Due primarily to the variability, even within peak periods, of C&NW frequencies, and the uncertain effect of frequency upon travellers who arrive at stations in a non-random manner, the former approach was selected.

The variables ΔCOM and ΔF are both assumed quantities and effect each individual in the same manner regardless of the location of the origin or destination. As a consequence, assumptions and sensitivity analyses with regard to these variables were made to reflect combined effect [ΔCOM + ΔF] rather than their separate effects. Because of the absence of a priori data concerning the value of [ΔCOM + ΔF], a range of values was investigated.

[1/] Lisco, Thomas E., The Value of Commuters' Travel Time - A Study in Urban Transportation, unpublished Ph.D. dissertation, University of Chicago, 1967.

TRANSFORMATION OF DISUTILITY DIFFERENCES TO DIVERSION PROBABILITIES

The results of the previous section yielded ΔDU for each individual in the sample for assumed values of travel time and comfort and convenience factors. Since a person who stands to "save" \$1.00 per trip using the CTA instead of the C&NW (i.e., ΔDU = \$1.00) is much more likely to divert than one who only stands to save \$0.05 per trip, it is desirable to transform the ΔDU to probabilities of diversion rather than merely assign individuals to the "cheapest" mode in terms of disutility. To do this, either a logistic or cumulative normal transform could be used. For computational convenience the former has been selected so that

$$P(CTA) = \frac{e^{\alpha \Delta DU}}{1 + e^{\alpha \Delta DU}}$$

in which P(CTA) = Probability of diverting to the CTA

ΔDU = Total trip disutility difference (in \$)

e = the natural number, 2.7183

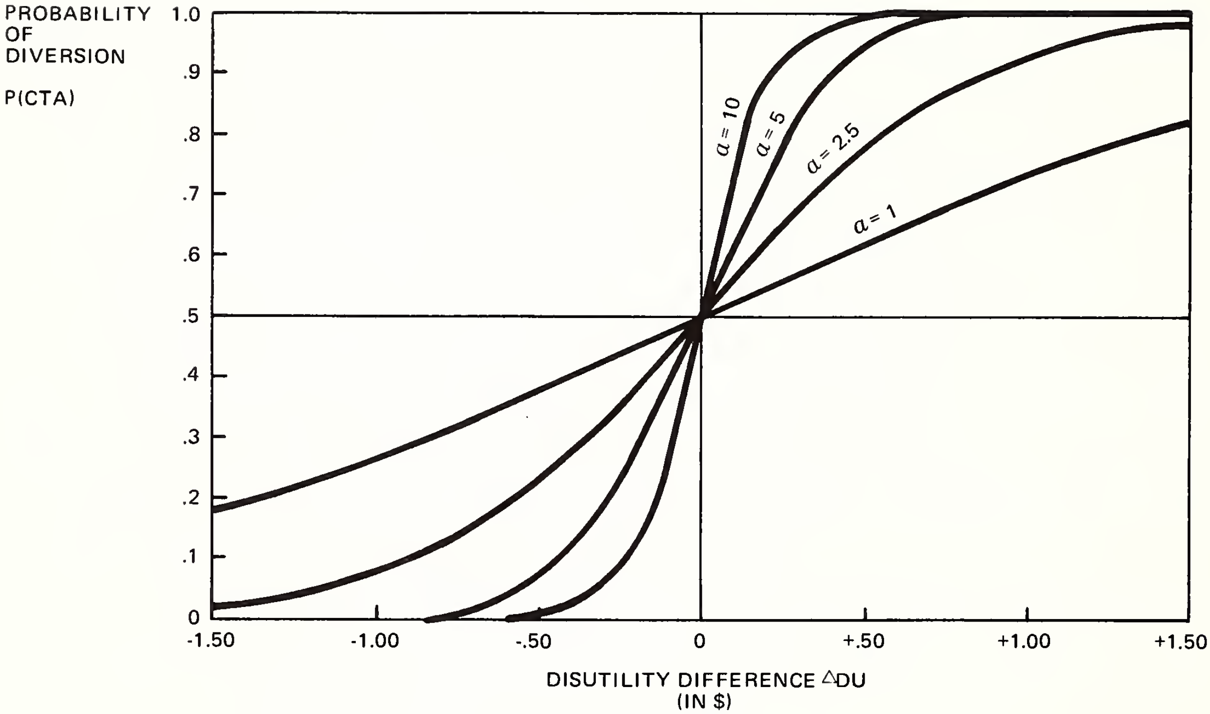
α = a constant

The constant α must be selected on a judgement basis.

Investigations of previous research using disaggregate modal split models for auto-transit choice situations indicate that values of α ranging from .8 to 2.0 would be consistently in line with the results of these models.[1/]

[1/] See, for example, Stopher, P.R. and Lavender, J.O., "Disaggregate, Behavioral Travel Demand Models: Empirical Tests of Three Hypotheses," paper to be presented to the Annual Meeting of the Transportation Research Forum, November 1972; Wigner, Martha, Unpublished CATS research; and Lisco, Thomas, The Value of a Commuter's Travel Time: A Study in Urban Transportation, unpublished Ph.D. dissertation, University of Chicago, 1967.

Figure C-2
Effect of Constant a on
Diversion Logistic Transform[1]



[1] $P(CTA) = \frac{e^{a(\Delta DU)}}{1 + e^{a(\Delta DU)}}$

Note that the α parameter corresponds to the coefficient of the Δ cost term in these models. Figure C-2 illustrates the effect of α on the logistic transform.

The output of this transformation analysis was probabilities of diversion for each individual in the sample for various input variables and policy assumptions.

CONVERSION OF DIVERSION PROBABILITIES INTO DIVERSION FORECASTS

For each C&NW station, forecasted probabilities of diversion to CTA service (P(CTA)) were summed for all individuals sampled to obtain an expected number of passenger diversions by station. These results were then factored to 1971 patronage levels on a station-by-station basis to forecast the total number of passengers who would switch from the C&NW to CTA service. The process was repeated for different values of line-haul travel time, V, (ΔCOM + ΔF), and alternative parking, fares, and feeder bus policies.

VALIDATION PROCEDURE

Ideally, the diversion estimation procedure just described should be validated using a random sample of ticket-by-mail subscribers selected for a period <u>prior</u> to the opening of the CTA Kennedy extension to Jefferson Park. Unfortunately, it was not possible to obtain such a sample. However, it was possible to obtain cancellations of ticket-by-mail subscribers since February 1970. It was felt that if the diversion estimation procedure could reasonably replicate the diversions of ticket-by-mail subscribers who cancelled since February 1970 and could make forecasts of future diversions which are in general agreement with past experience, the model could be considered a valid tool for forecasting passenger diversions.

The major drawback experienced in attempting to validate the procedure with ticket-by-mail cancellations was that the proportion of ticket-by-mail subscribers who cancelled since February 1970 who actually diverted to the CTA was not known. Some of the cancellations were due to external reasons not related to the CTA. To estimate the "actual" share of subscribers who diverted, cancellation "turnover rates" were computed for non-impacted stations and then applied to impacted stations. Using the model and the cancellation ticket-by-mail subscribers for impacted stations as input, diversions of ticket-by-mail subscribers who cancelled were forecasted for ranges of the value of line-haul travel time, (ΔCOM + ΔF), and α.

The best agreement between the "actual" diversions estimated using turnover rates and the model forecasts occurred at a value of line-haul time of $2.50 per hour, $\alpha = 7.5$, and (ΔCOM + ΔF) varying between 0 and +$.25 in favor of the CTA. The model showed tendencies to overestimate diversions at C&NW stations further from Jefferson Park with (ΔCOM + ΔF) = +$.25 and to slightly underestimate diversions at these stations with (ΔCOM + ΔF) = 0. At stations closer to Jefferson Park the forecasts with (ΔCOM + ΔF) = +$.25 were generally more satisfactory. By themselves, however, these results must be viewed very cautiously. In effect, the results of one model were compared with the results of another model since the actual diversions by subscribers who cancelled were not known. Therefore, it was felt necessary to check future model diversion forecasts against past diversions on an aggregate level for general agreement. Without such agreement, it would not be possible to use any forecasts of future diversions with confidence.

Using the year from February 1969 through January 1970 and the year from November 1970 through October 1971 as a basis, diversions resulting from the CTA extension to Jefferson Park were computed, station by

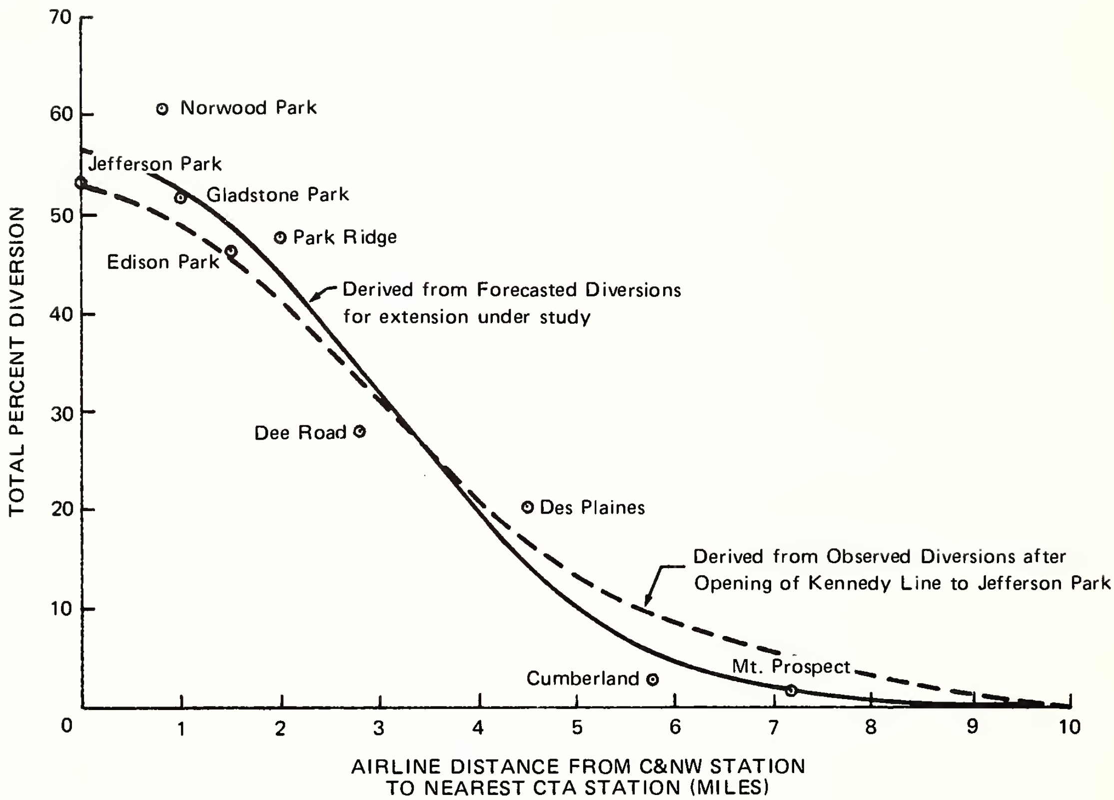
station. These diversions were adjusted to account for the probable growth in passenger volumes which would have been experienced at these stations had the CTA not been extended. When these diversions were plotted against the airline distance between the C&NW station in question and the closest CTA station, a remarkably smooth S-shaped curve resulted. This curve is shown by the dashed line on Figure C-3.

Using forecast #3 from Table C-1 and the past diversions, the total diversions by station which would be expected (since February 1970) if the Kennedy line were extended beyond Jefferson Park to Harlem Avenue and River Road were plotted on Figure C-3.[1/] This forecast was made using $\alpha = 7.5$, V = \$2.50 per hour, and (ΔCOM + ΔF) = 0. Overall there is general agreement between the results of this forecast and the curve derived from past diversion experience. A similar plot using a forecast based on a value of (ΔCOM + ΔF) = +\$.25 showed significant divergence between past experience and forecasted results.

When the results of the analysis of ticket-by-mail cancellations and the comparison of forecast results against past experience are viewed together, it appears that the model constitutes a valid forecasting tool when used with V = \$2.50 per hour, $\alpha = 7.5$, and (ΔCOM + ΔF) = 0. A value of $\alpha = 7.5$ as opposed to a lower value indicates that travellers more frequently choose the "cheaper" mode in terms of disutility, even if the disutility difference between modes is small (refer to Figure C-2). A value of (ΔCOM + ΔF) of zero may be interpreted as meaning that the value of the greater service frequency of the CTA equals and offsets the value of the superior comfort afforded by the C&NW.

[1/] For stations from Jefferson Park through Mt. Prospect.

Figure C-3
Validation Results Forecasted and Observed Total[1] Diversions by Station vs. Distance to Nearest CTA Station



[1] Includes diversions due to CTA extension to Jefferson Park plus forecasted diversions (Forecast #3, Table C-1) due to an extension of CTA service to Harlem Avenue and River Road Stations

ANALYSIS RESULTS

Using the analysis procedure that has been described, forecasts were developed of the potential passenger diversions from the C&NW to the CTA which would occur if Kennedy line service is extended to Harlem Avenue and River Road stations. Forecasts were prepared which were not only contingent upon the values of the input parameters, α, (ΔCOM + ΔF) and V, but also on different assumptions regarding CTA station parking, availability of feeder bus service, and CTA fare level. Table C-1 summarizes these forecasts.

Using the same general analysis procedure, diversion forecasts were also prepared for the Milwaukee Road West line which are summarized in Table C-2. For the Milwaukee Road forecasts, a detailed computer analysis was required for only Forecast Number 3 since the forecasts for different service assumptions could be developed using the C&NW results. Additionally, the following points should be noted concerning the Milwaukee Road analysis -- diversions were based on 1970 volumes; the weighted average fare by station was assumed to equal the unlimited weekly ticket change divided by ten; and some of the individual station diversions were adjusted to conform more closely with the curves of Figure C-3. Described below are the various assumptions made and tested in the diversion analysis.

Logistic Transform Parameter - α

Forecasts were prepared using α = 7.5. Although a priori information derived from auto-rail mode choice models suggested that α = 1.0 would be an appropriate value, the validation process clearly achieved the best results with a value of 7.5. In retrospect it appears that it would not be realistic to expect that α should be the same in a situation where travelers are choosing between two rail modes as it would in a situation where persons

TABLE C-1

FORECAST SUMMARY - C&NW NORTHWEST LINE

Forecast [1/]	(ΔCOM + ΔF)	α	CTA Fare	Feeder Bus	Station Parking	Percent Diversion [2/]	Annual Patronage Loss (thousands)	Annual Revenue Losses (thousands)	Parking Spaces Required [3/]
1	0	7.5	\$.45	Yes	Yes	15.1	1,400	\$1,000	410
2	0	7.5	.55	Yes	Yes	12.1	1,200	800	330
3	0	7.5	.55	No	Yes	9.1	860	600	520
4	0	7.5	.55	No	No	6.1	580	390	None
5	0	7.5	.70	No	No	4.2	400	260	None

1/ All forecasts shown assume a value of line-haul time of \$2.50 per hour.

2/ Based on C&NW passenger volumes from Irving Park through Barrington.

3/ Total spaces required to accommodate former C&NW riders at Harlem Avenue and River Road stations.

TABLE C-2

FORECAST SUMMARY - MILWAUKEE ROAD WEST LINE

Forecast[1]	(COM + F)		CTA Fare	Feeder Bus	Station Parking	Percent Diversion[2]	Annual Patronage Loss (thousands)	Annual Revenue Losses (thousands)	Parking Spaces Required[3]
1	0	7.5	$.45	Yes	Yes	16.0	188	$147	60
2	0	7.5	.55	Yes	Yes	13.8	162	126	40
3	0	7.5	.55	No	Yes	9.9	116	91	70
4	0	7.5	.55	No	No	6.6	77	59	None
5	0	7.5	.70	No	No	4.6	54	40	None

1/ All forecasts shown assume a value of line-haul time of $2.50 per hour.

2/ Based on Milwaukee Road passenger volumes from Elmwood Park through Itasca.

3/ Total spaces required to accommodate former Milwaukee Road riders at Harlem Avenue and River Road stations.

are choosing between auto and rail. Because travelers choosing between two rail modes can more accurately and consistently evaluate the costs of the alternative modes, it is logical to expect that they might behave in a more "rational" manner, i.e., choose the "cheapest" mode more frequently. This implies a higher value of α.

Value of Line-Haul Time - V

A change in the value of line-haul travel time from $2.50 to $3.00 has a less than 1 percent change in the overall diversion. Because CTA line-haul times remain constant as the distance from the origin to the CBD increases, increases in the value of line-haul travel time tend to increase forecasted diversions at far out C&NW stations (where CTA has line-haul time advantage) while decreasing the diversions at close in stations (where C&NW has line-haul time advantage). This result points to the unrealistic effects of varying the value of line-haul time without varying in a consistent manner the value of station access time. Since the use of disutility-distance relationships effectively precludes the possibility of varying the value of station access time,[1/] a single value of line-haul travel time was used in developing the forecasts shown in Tables C-1 and C-2, $2.50 per hour. Given the insensitivity of the results to changes of ±$.50, this value is quite adequate for forecasting purposes.

[1/] It could be done by modifying the value of time assumptions used to construct the relationships and then rebuilding them. This, however, would be a time consuming and costly process which would be unjustified given that these relationships were developed explicitly for commuter rail corridors.

Comfort, Convenience and Frequency (ΔCOM + ΔF)

As indicated previously, a value of (ΔCOM + ΔF) = 0 produced the most satisfactory validation results. As a consequence all of the forecasts shown in Tables C-1 and C-2 were prepared using this value.

Feeder Bus Service

Forecasts were developed assuming both the existence and non-existence of CTA feeder bus service to the Harlem Avenue and River Road stations. The provision of such service would increase diversions from 9 percent to 12 percent. It should be noted that because much of the impacted area lies outside the City of Chicago, it might be unreasonable to expect that $.10 surcharge CTA-type feeder bus service could be provided.

Station Parking

The Harlem Avenue and River Road stations could be built with or without parking facilities. As a consequence, the forecasts shown in Tables C-1 and C-2 reflect alternative assumptions regarding the provision of parking and indicate the number of spaces which would be required for former commuter rail riders if parking is assumed to be available to anyone who desires it at 25 cents per day.

CTA Fare Level

Since there are precedents for premium or special fares on other CTA rapid transit service,[1/] it is quite possible that a fare above the standard

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[1/] The Evanston Express and the Skokie Swift.

$.45 might be charged. Several fare levels were tested. Assuming the existence of feeder bus service and parking, a CTA fare increase from $.45 to $.55 decreases the forecasted C&NW diversions from 15 percent to 12 percent.

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APPENDIX E

CONSTRUCTION COST ESTIMATE BREAKDOWNS

ALTERNATIVE #1 -- CTA EXTENSION/DISTRIBUTOR SYSTEM

CTA Extension estimate (see Alternative #4)	$79,925,000
Tunnel Allowance, Milwaukee Service to Distributor System, at Des Plaines Street	8,870,000*
	$88,795,000

*Obtained as follows:

Total cost estimate for tunnel (provided by Bureau of Engineering, City of Chicago DPW) in 1971 dollars, escalated to 1972 dollars at 7.5%, the allowance being 1/2 of result. ($16,500,000 x 1.075 x .5 = $8,870,000.) One-half the total cost was judged to be a reasonable allowance applied to this alternative as this tunnel would also offer increased flexibility of operation and Loop reversal for conventional Milwaukee Service trains.

ALTERNATIVE #2 -- CTA/C&NW/DISTRIBUTOR SYSTEM

The following estimate assumes that a separate, two-track system would be constructed on the existing C&NW right-of-way.

Civil Work on C&NW ROW		
Bridges	$ 5,990,000	
Retaining Walls	5,610,000	
Fill, in Walls	1,275,000	
Fill, Without Walls	3,180,000	
Railroad Crossing Bridges	2,300,000	
Contingency, and Allowance for Constructibility	1,835,000	
		$ 20,190,000
Track Work on C&NW ROW		
Relocation	$ 580,000	
Track	3,640,000	
Re-signaling and Communications	360,000	
Miscellaneous Switches and Track	200,000	
		$ 4,780,000
New Signals and Controls (Grand Avenue-Jefferson Park, 8.1 miles)		
Signal System	$ 1,916,000	
Communications System	1,350,000	
		$ 3,266,000
New Connections		
Incline at Jefferson Park, C&NW to CTA	$ 3,500,000	
Bridge-Tunnel at Grand Avenue, C&NW to Distributor Tunnel	6,500,000	
Tunnel at Des Plaines Street, Milwaukee Subway to Distributor*	8,870,000	
		$ 18,870,000
Sub-Total, New Construction		$ 47,106,000
CTA Extension Estimate (see Alternative #4)		79,925,000
TOTAL		$127,031,000

*See note, Alternative #1.

ALTERNATIVE #2 -- CTA/C&NW/DISTRIBUTOR SYSTEM

The following estimate assumes a major upgrading of signals and controls on the C&NW right-of-way would permit premium service operation on the existing track system.

Civil Work on C&NW ROW	$ 2,300,000
Track Work on C&NW ROW	$ 300,000
New Signals and Controls	$ 4,500,000
New Connections	$ 18,870,000
Sub-Total, New Construction	$ 25,970,000
CTA Extension Estimate (see Alternative #4)	$ 79,925,000
TOTAL	$105,895,000

ALTERNATIVE #4 -- CTA EXTENSION (JEFFERSON PARK-O'HARE)

	1970 Dollars*	
Civil ROW Work		
Bridges	$ 2,543,000	
Tunnels and Associated Misc.	18,153,000	
Grading and Walls	3,739,000	
Track and Track Work	6,021,000	
Miscellaneous	445,000	
		$ 30,901,000
Station Construction		
Airport Station Work	$ 2,897,000	
Intermediate Stations and Parking	14,626,000	
Station Terminal Facilities	4,803,000	
		$ 22,326,000
Power and Electrification		
Substations	$ 1,995,000	
Electrification	2,470,000	
		$ 4,465,000
Signals and Controls		
Signal System	$ 2,614,000	
Communication System	1,313,000	
		$ 3,927,000
Allowance for Airport Systems' Vehicle Storage and Maintenance Facilities		($ 1,240,000)
Engineering and Contingency		$ 9,121,000
Sub-Total		$ 69,500,000
15% Escalation to Bring to 1972 Estimate		10,425,000
TOTAL		$ 79,925,000

*Figures are based on estimate provided by Bureau of Engineering, City of Chicago DPW.

ALTERNATIVE #5 -- CTA/C&NW TERMINAL

The following estimate assumes that a separate, two-track system would be constructed on the existing C&NW right-of-way.

Civil Work on C&NW ROW*		$ 20,190,000
Track Work on C&NW ROW*		$ 4,780,000
New Signals and Controls (C&NW Station-Jefferson Park, 9.1 miles)		
Signal System	$ 2,152,000	
Communications System	1,516,000	
		$ 3,668,000
New Connections		
Incline at Jefferson Park, C&NW to CTA		$ 3,500,000
C&NW Station Modifications		
Terminal Track Work and Switch		$ 30,000
Sub-Total, New Construction		$ 32,168,000
CTA Extension Estimate (see Alternative #4)		$ 79,925,000
TOTAL		$112,093,000

*See Alternative #2.

ALTERNATIVE #5 -- CTA/C&NW TERMINAL

The following estimate assumes a major upgrading of signals and controls on the C&NW right-of-way would permit premium service operation on the existing track system.

Civil Work on C&NW ROW	$ 2,300,000
Track Work on C&NW ROW	$ 300,000
New Signals and Controls	$ 4,500,000
New Connection	$ 3,500,000
C&NW Station Modifications	$ 30,000
Sub-Total, New Construction	$ 10,630,000
CTA Extension Estimate (see Alternative #4)	$ 79,925,000
TOTAL	$ 90,555,000

APPENDIX F

OPERATING COST ANALYSIS

ALLOWANCES, ASSUMPTIONS, AND BASIS FOR CALCULATION

- Average peak day air passenger ridership is 17 percent of weekly ridership.

- Peak hour air passenger ridership is 10 percent of average peak day ridership.

- Premium fare terminal-terminal line haul time is approximately 90 minutes, including turnaround, for Alternative #1, 75 minutes for Alternative #2, 85 minutes for Alternative #4, and 50 minutes for Alternative #5.

- Premium fare service headway ranges from 15 minutes during peak periods to 20 minutes during off-peak.

- Operation of premium fare service is for 20 hours per day.

- A car for premium service seats 40 persons.

- All trains must have an even number of cars.

- Premium service car spares factors are as follows: Alternative #1 - 12 percent; Alternative #2 - 15 percent; Alternative #4 - 10 percent; and Alternative #5 - 15 percent. For local service, spares factor is 10 percent.

- Premium fare vehicle costs per car mile are as follows: Alternatives #1 and #4 - $1.19; Alternatives #2 and #5 - $1.30. All local service car mile costs are $1.19.

- Premium fare maximum train length is 10 cars; minimum train length is 2 cars.

- Weekend car miles are approximately 2/3 weekday car miles for premium service.

- Average headway for local service to airport and intermediate stations during 4 hours/day is 6 minutes; for 16 hours, average headway is 12 minutes.

- Average peak hour airport employees are 25 percent of average peak day riders.
- Peak hour average maximum passenger loading is 83 persons, for local service.
- Annual car miles per car for local service is estimated at 42,000 miles.
- Fare to CBD from intermediate stations (between Jefferson Park and O'Hare) is $.55.
- Distances assumed are as follows: Lake-O'Hare, 17 miles; Northwestern Station-O'Hare, 17 miles; Jefferson Park-O'Hare, 8 miles; Grand Avenue-Jefferson Park, 8 miles; Loomis-Jefferson Park, 11.6 miles.
- Annual use charge callowance for C&NW Terminal, for Alternative #5, is $600,000 at 474 car entry/day level.
- Annual C&NW right-of-way rental allowance for Alternatives #2 and #5, $885,000.
- All figures rounded off to nearest $10,000.

APPENDIX G

WORK FLOW DIAGRAM
FOR STUDY

CORPORATE OFFICE
WESTGATE RESEARCH PARK
McLEAN, VIRGINIA 22101
703/893-4310